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This Conference brought together practicing educators at all levels to present their methods and techniques of utilizing the concept of the marine sciences within the educational spectrum. Included are descriptions of extant programs, discussions of specific ways to use the marine environment for instructional purposes, papers directed at the role of oceanology in the curriculum, papers on industrial cooperation in this area, and papers on specific instructional techniques such as the use of visual aids and field trips. (RS)

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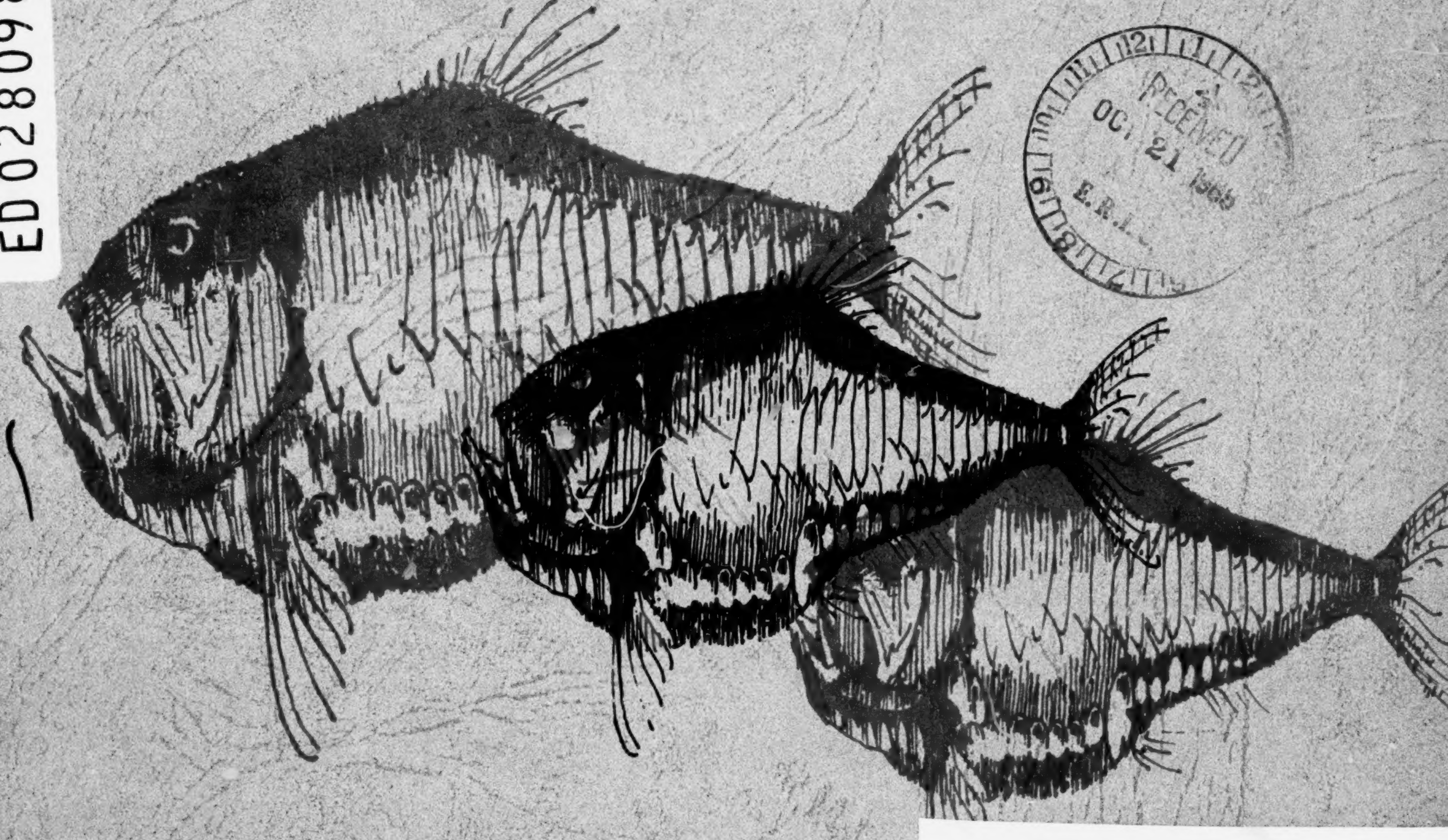

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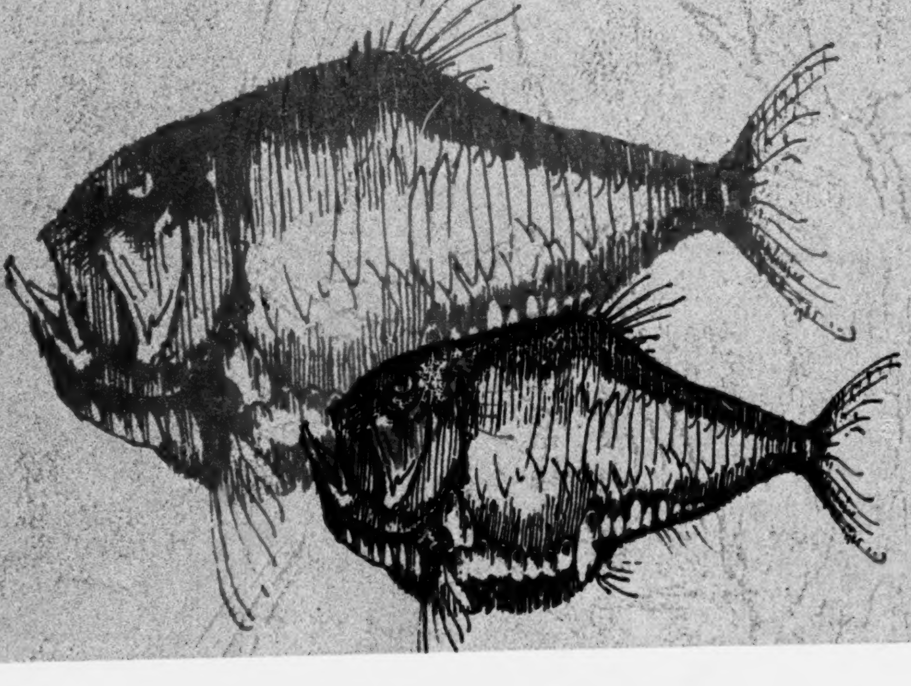
Proceedings of The Marine Sciences in Education Conference

MAY 4, 1968



ORANGE COUNTY SCHOOLS
MARINE SCIENCE FLOATING
LABORATORY

UNIVERSITY OF CALIFORNIA IRVI
DEPARTMENT OF POPULATION A
ENVIRONMENTAL BIOLOGY

SE 006 542

Orange County

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PROCEEDINGS

OF

SOUTHERN CALIFORNIA CONFERENCE

ON THE MARINE SCIENCES IN EDUCATION

May 4, 1968

UNIVERSITY OF CALIFORNIA, IRVINE

PREFACE

The role of the marine sciences is rapidly emerging as a major component of modern educational programs. The irony is, however, that we know more about the moon's behind than we do the ocean's bottom! A lot of "catching up" has to happen!

Providing young people the experiences and opportunities to better understand this environment will doubtless provide direction towards an appreciation of the ocean's potential and maintenance for the future.

California will become by 1970 the home of one out of every ten Americans. With this in mind, it is incumbent on Southern California educators to commence the development of programs aimed towards building an understanding of this vital environment and its safeguard for the future. These educational endeavors should have as a prime goal the building of positive attitudes towards this vital environment that accounts for 70% of our world.

In an attempt to demonstrate the level of commitment toward the marine sciences in contemporary education the Southern California Conference on The Marine Sciences in Education was held on the campus of the University of California, Irvine. The conference brought together practicing educators from elementary through the university level. They presented to the assembled participants their methods and techniques of utilizing the concepts of the marine sciences within the educational spectrum.

The conference was made possible through a high degree of cooperation between the Orange County Schools Marine Science Floating Laboratory Program, the University of California, Irvine, Department of Population and Environmental Biology.

Special thanks goes to those participants whose efforts are presented in these proceedings.

Ronald B. Linsky
Conference Chairman

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A NEW APPROACH TO MARINE BIOLOGY ON THE HIGH SCHOOL LEVEL

A NEW APPROACH TO MARINE BIOLOGY ON THE HIGH SCHOOL LEVEL

by

William L. Brisby
Fillmore High School
Fillmore, California

The need for properly trained marine biologists is becoming more and more important with the research now being undertaken throughout the county. To meet this rising demand for trained personnel, we need to provide a positive program for the more highly endowed and motivated high school students before they have become involved in other areas and disciplines at a university. It is not solely the responsibility of educational institutions to train our superior students. This marine biology program was developed to allow for a cooperative utilization of military, industrial, and academic personnel and facilities in order that this much needed extra-curricular training might be accomplished.

With the passage of the "Marine Resources and Engineering Development Act of 1966," a comparatively new scientific discipline was brought to the attention of school administrators and science teachers who, for the most part, have little or no background in the marine sciences. Two objectives of the act are particularly applicable to secondary school science programs. They are expressed as follows: "The marine science activities of the United States should be conducted so as to contribute to the following objectives: . . . the expansion of human knowledge of the marine environment, and . . . the advancement of education and training in marine sciences."[1]

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[1] Effective Use of the Sea, Report of the Panel on Oceanography of the President's Science Advisory Committee, page 136, June 1966.

THE VENTURA COUNTY PROGRAM

The Naval Missile Center, Point Mugu, California, is a leading contributor to marine biology research conducted by the United States Navy, and therefore is cognizant of the importance of early training for those interested in pursuing a career in marine biology. In February 1966, the Naval Missile Center in cooperation with Ventura College instituted a 1-semester pilot program for high school and junior college students with high ability. In this program, lectures in marine biology were given by leading authorities. These were followed by laboratory sessions in the field which gave students an opportunity to experience at firsthand some of the activities involved in marine biology research. This pilot program met with such favorable acceptance that it was expanded in the fall of 1966 to a full year course with a correspondingly wider offering for the participants.

Since then the course has been developed further under the guidance of a steering committee composed of professional research biologists, county school and college administrators, commanders of Naval installations in Ventura County, and college and high school classroom biology teachers. The scientific community in Ventura County has been very active in the program and has given invaluable assistance.

At present, the course is being given at the Naval Missile Center. A grant from the National Science Foundation makes possible an even more diversified and thorough program for both students and teachers than was possible in 1966.

The lectures are given one evening each week by authorities speaking in areas of their primary interest. The laboratory sessions are held on Saturdays and involve the participants in ecological studies of the Mugu Lagoon and the offshore islands, as well as visits to marine research institutions.

LECTURE SESSIONS

This course is divided into 6 units: oceanography, marine botany, invertebrate zoology, vertebrate zoology, physiology of marine organisms, and new frontiers in marine biology. This gives the participants in the program an overall view of marine biology, and does not tie them down to a specific area at the expense of achieving the primary purpose of this course, i.e. to provide a basic and introductory course in marine biology.

The lectures are given one evening each week by authorities speaking in areas of their primary interest. By having lecturers who are authorities, the students and teachers have an opportunity to become acquainted with not only the basic knowledge of the subject but also enable students to discuss at depth with the lecturer any individual questions or problems they may have pertaining to their research.

The week prior to the lecture, outlines of the lecture and a list of suggested references are provided the participants for study. Each lecturer is asked to provide a 10 question quiz over the suggested reference material at the beginning of the class period to make possible an evaluation of the students' understanding of the outside reading.

Planning sessions for the lecturers in each unit are held prior to the start of the unit. To achieve a carry-over and intergration of one lecture with the next, each lecturer is provided with a syllabus of the course which lists its aims, objectives, and philosophy, and includes the outlines of each lecture in the course.

LABORATORY PROGRAM

The core of the course is the students' participation in field work with an opportunity to develop, organize, and follow through on his own research problem, including the writing and presentation of a paper based on his research. In the first 2 years of the program, students have done research on diverse subjects as the following titles of papers demonstrate: The Concentration of Enteric Pathogens in Selected Mollusca, The Migration of _Dendraster elongatus_ in Mugu Lagoon, The Effect of pH on the Distribution of Foraminifera in Mugu Lagoon, Salinity Tolerances of the Genus _Callianassa_, and the Angle of Beach Slope as a Factor in the Distribution of _Emerita analoga_.

From the laboratory work, the students have developed an entirely new concept of what biological research may or may not be. Many have been encouraged by this research to experience and investigate an entirely new field which they may, in the future, wish to enter professionally. For the others, experiencing the challenges, accomplishments, and frustrations that are a part of scientific research has provided them with greater appreciation of science and the place of the scientist in our society. A survey of the graduates of the first 2 years of the program indicates that 30% are now preparing for careers in marine biology while another 50% are majoring in some field of biology.

Also, through the cooperation of the Naval Missile Center, Naval Civil Engineering Laboratory, and Ventura Industry-Education Council, outstanding students from this course are given employment for the summer to work in some area of biology (wherever possible in marine biology).

TEACHER PARTICIPATION

A persistent demand has been made by science teachers for a course in marine biology which would give them an opportunity to upgrade their teaching. The program includes teachers as well as students. The majority of teachers participating in this course have had no training in marine biology per se. The lecture sessions are of particular interest and value to them as they provide the teachers with an opportunity to delve further into subject matter that is directed toward the marine environment. While the teachers are not expected to participate in all the laboratory sessions, they are expected to participate in certain designated sessions which are structured in such a way as to enable them to apply the factual information of the classroom to field study. The knowledge gained from the field work makes it possible for them to diversify their classroom teaching and to make better use of the county's marine environment. This also allows them to use this marine environment to point out not only biological principles but also the practical applications of these principles.

FACILITIES AND EQUIPMENT

The high schools participating in the course are provided with a basic marine biology library and with some equipment needed for field studies such as seines, dip nets, hydrometers, thermometers, specimen bags, etc.

The equipment of the Marine Bioscience Branch at the Naval Missile Center is also available to the class for use when carrying out research projects. At the Naval Missile Center, the main building used for this course houses an extensive study collection of marine organisms indigenous to the area. It also contains 18 tanks ranging in size from 20 to 500 gallons. Nearby are 25 outdoor tanks ranging in size from 20 to 800 gallons. All tanks have a constant supply of fresh sea water circulated through them. Microscopes (dissecting, stereozoom, monocular, and binocular) and photomicrographic equipment is also available. The Naval Missile Center maintains an up-to-date marine biology library and study area which makes it possible for students to carry out reference and research work not otherwise possible in their own school or community.

Laboratory facilities are available to make the various required chemical tests and analyses. A professional laboratory technician is available to instruct and assist in the use of the more refined components of the laboratory. This laboratory makes use of equipment such as a: colorimeter, flamephotometer, ultra-micro system (colorimeter-spectrophotometer, titrator, and centrifuge), chloridometer, gas chromatograph with hydrogen flame and recorder, and an oxygen analyzer.

Five 9 foot johnboats, 2 Boston whalers, and 3 other small craft are available for use in the Mugu Lagoon. Since this program is sponsored by the Naval Missile Center, it is also possible at times to use some Naval surface craft such as an 85 foot Navy aviation rescue vessel to go to the offshore islands.

The Mugu Lagoon, a part of the Naval Missile Center and open only to those doing scientific research, is one of the few undisturbed lagoons in Southern California. It is the site for most of the laboratory work. A recent survey of the flora and fauna in the lagoon by Professor and Mrs. George Mac Ginitie and a study of the deposition of organisms in the lagoon by John E. Warme has laid an excellent foundation upon which the students may develop their research.

Besides the equipment and facilities provided, professional researchers and scientists in marine biology and oceanology from nearby Naval activities are always readily available for consultation and assistance. Through the participation of the Ventura Industry-Education Council, scientists from private industries (General Motors, Northrop Ventura, North American, Westinghouse, etc.) are also easily reached by the students for consultation and assistance in research work.

SELECTION OF PARTICIPANTS

Candidates are selected by a committee composed of the course directors and representatives of the county school offices, the Naval Missile Center, the Naval Civil Engineering Laboratory, and the Ventura Industry-Education Council. This committee makes its selection from nominees provided by each of the participating high schools in the county. Because of the importance of getting quality in the instruction, the course is limited to 10 teams (20 students and 10 teachers).

Minimum qualifications for students include completion of high school biology, chemistry, and 2 years of mathematics. Experience has shown that students should have 3 years of mathematics rather than 2, and they should be taking physics concurrently with the marine biology course.

SUMMARY

This program has been developed to give high schools an opportunity to up-date their science offerings in the area of marine biology. The student participants are afforded an opportunity to experience a field of study not included in their regular curriculum and to participate in marine research which may suggest future career possibilities.

The teachers are given an opportunity to up-date their laboratory techniques and knowledge in marine biology as well as to lead outstanding seniors in their school in individual research with equipment and materials not normally available to them.

Lectures given by authorities bring out not only basic information but also recent research in marine biology while laboratory sessions consisting of a study of the comparative ecology of estuarine and open ocean habitats, visits to scientific research facilities, and experiences on oceanographic research vessels.

Accelerated technological and scientific advances have presented an increasing challenge to educational institutions. This challenge can be met in part by communities willing to assume part of the burden by developing the potential of superior students. In addition, training in the scientific disciplines, which often requires highly specialized equipment and facilities, demands cooperative utilization of community resources. It is not solely the responsibility of educational institutions to train our superior students. This marine biology program was developed to allow for a cooperative utilization of military, industrial, and academic personnel and facilities in order that this much needed extra-curricular training might be accomplished.

SYLLABUS FOR LECTURE
and
LABORATORY SESSIONS

UNIT I -- Physical Oceanography

Historical Background of Marine Biology
The Chemistry of the Sea
Physics of the Sea and Waves
The Effects of Tides and Currents on the Marine Biome
Zonation and Distribution of Marine Organisms
Marine Geology -- Its importance to Marine Biology

UNIT II -- Marine Microbiology and Botany

Microbial Processes in the Sea
Effects of Physical and Chemical Factors on Marine Micro-organisms
The Place of Algae in the Marine Ecosystem
Marine Algae -- Aspects of Productivity
Quarter Final

UNIT III -- Marine Invertebrates

Fundamental Physiological Processes Utilized by the Coelenterates
Physiological Diversity in Echinoderms
Biochemical Relationships of Marine Worms to Their Environment
Physiological Adaptations of Marine Arthropods for Life in the Sea
Morphological Diversity in Relation to Molluscan Distribution

UNIT IV -- Marine Vertebrates

Evolutionary Adaptations in the Chondrichthyes
Analogous and Homologous Structures in Osteichthyes
Navigation and Salt Regulation in Marine Birds
Evolutionary Divergence in Pinnipeds
Physiological Adaptations in Cetaceans
Quarter Final

UNIT V -- Physiology of Marine Organisms

Food Chains & Energy Relationships in the Marine Environment
Respiratory and Excretory Adaptations of Marine Organisms
Physiological Adaptations of Marine Organisms for Movement and Defense
Reproductive and Embryological Processes in Marine Organisms
Physical and Chemical Factors Affecting Growth Rates in Marine Organisms

UNIT VI -- New Frontiers in Marine Biology

Marine Fouling Organisms as a Continuing Problem in the Sea
Deep Submersibles -- New Research Tools
Deep Ocean Biology -- New Frontier
Sea Lab Project -- Its History & Expectations
Cetacean Research and Its Implications
Man's Future in the Sea
Final

N.M.C. MARINE BIOLOGY INSTITUTE LECTURERS

Dr. Shelton Applegate, Associate Curator, Vertebrate Paleontology, Los Angeles County Museum of Natural History

Dr. Gerald J. Bakus, Assistant Professor of Biological Sciences University of Southern California

Mr. James Castren, Instructor, Ventura College

Dr. Paul C. Denny, Assistant Professor of Zoology, University of California at Los Angeles

Mr. Max L. Eaton, Mathematical Statistician, Naval Civil Engineering Laboratory, Port Hueneme

Mr. William Evans, Staff Scientist, U.S. Navy Undersea Warfare Center

Mr. John Fitch, Research Director, California State Fisheries Laboratory, Terminal Island

Mr. Arthur Flechsig, Aquanaut Sea Lab II, Scripps Institute of Oceanography

Dr. John Garth, Professor of Biological Sciences, University of Southern California; Curator of Collections, Allan Hancock Foundation, University of Southern California

Mr. Robert Green, Instructor, Ventura College, Research Biology, U.S. Navy Undersea Warfare Center

Mr. David W. Hill, Head, Editorial Branch, Technical Publications Division, Photo/Graphics Department, Naval Missile Center, Point Mugu, California

Dr. Donald E. Landenberger, Assistant Professor of Zoology, University of California, Los Angeles

Dr. James H. McLean, Curator of Invertebrate Zoology, Los Angeles County Museum of Natural History

Mr. James Muraoka, Biologist and Senior Project Scientist, U.S. Naval Civil Engineering Laboratory, Port Hueneme

Dr. Leonard Muscatine, Associate Professor of Zoology, University of California at Los Angeles

Dr. Robert Norris, Professor of Geology, University of California at Santa Barbara

Mr. Thomas O'Brien, Research Hydraulic Engineer, Naval Civil Engineering Laboratory

Dr. Thomas B. O'Neill, Instructor, Division of Life Science, Ventura College, Research Biologist, Naval Civil Engineering Laboratory

Mr. Ralph Penner, Psychologist, U.S. Navy Undersea Warfare Center

Mr. John H. Prescott, Curator of Animals, Marineland of the Pacific

Dr. Andreas B. Rechnitzer, Director of Ocean Science, Ocean Systems Operation, North American-Rockwell Company

Dr. Donald J. Reish, Associate Professor, Department of Biology, California State College at Long Beach

Dr. Sam Ridgeway, Research Veterinarian, U.S. Navy Undersea Warfare Center

Mr. Thorndyke Roe, Jr., Senior Project Scientist, Naval Civil Engineering Laboratory

Mr. James Smith, Diving Officer, University of California, Scripps Institute of Oceanography

Dr. John S. Stephens, Professor of Biology, Occidental College

Mr. Donald A. Villeneuve, Instructor, Ventura College

Dr. Harold P. Vind, Research Chemist, U.S. Naval Civil Engineering Laboratory, Port Hueneme, California

Mr. John E. Warme, Associate Professor, Geology, Rice University, Houston, Texas

Dr. R. B. Tibby, Professor, Allan Hancock Foundation, University of Southern California

Mr. Charles Turner, Marine Biologist & Diving Officer, California Department of Fish and Game

Dr. John Wintersteen, Associate Professor, Department of Zoology, University of California at Los Angeles

Mr. Carl Wisler, Operations Research Analyst, Pacific Missile Range

Mr. Fred C. Ziesenhenne, Captain of Marine Research Vessel Valero IV and Research Associate, University of Southern California

Dr. Donald Zimmer, Associate Professor of Zoology, University of Southern California

THE FOLLOWING LIBRARY WILL BE GIVEN TO EACH PARTICIPATING SCHOOL

Bascom, W. (1964), Waves and Beaches, Anchor Books, Doubleday & Co., Inc., pp. 267

Dawson, E. Yale (1966), Marine Botany, Holt & Co., Inc.

Light, S.F., et al, (1957), Intertidal Invertebrates of the Central California Coast, University of California Press, pp. 446

MacGinitie and MacGinitie (1949), Natural History of Marine Animals, McGraw-Hill Book Co., pp. 473

Moore, Hilary (1958), Marine Ecology, Wiley and Sons, Inc., pp. 493

Nicol, J.A. (1960), The Biology of Marine Animals, Interscience Publishers, Inc., pp. 707

Ricketts and Calvin (1962), Between Pacific Tides, Stanford University Press, pp. 365

Smith, Gilbert (1944), Marine Algae of the Monterey Penninsula, Stanford University Press, pp. 622

Svedrup, H. U. (1946), The Oceans, Prentice-Hall, pp. 1087

EQUIPMENT GIVEN TO EACH PARTICIPATING SCHOOL

- 1 seine 20' x 4'
- 3 nylon fish dip nets
    - 1 3" net
    - 1 5" net
    - 1 7" net
- 1 plankton tow net
- 1 scraper net
- 1 plant press
- 2 thermometers
- 1 insulated field container
- 6 sets plastic specimen bags
    - 3 6 1/2" x 8"
    - 3 11" x 13"
- 3 plastic buckets
- 1 field compass
- 1 windmeter
- 2 hydrometers

MARINE EDUCATION IN AN INDUSTRIAL LABORATORY

MARINE EDUCATION IN AN INDUSTRIAL LABORATORY

by

Robert Eberhardt
Research Scientist
Lockheed Aircraft Corporation

Marine education is required to overcome the scarcity of trained personnel who can work effectively at sea, along the waterfront, or in support facilities ashore. This need extends through all levels of employment. We must consider that space and national defense programs may be reoriented. Should such changes occur, then the level of effort expended in oceanic programs will increase, and today's needs for trained manpower will soar at an even greater rate than they do today.

The Lockheed Ocean Laboratory is only one of several industrial establishments dedicated to the study of the sea. This laboratory was the first industrial American facility so established with waterfront structures, a fleet of vessels including a submarine, and a staff of engineers and scientists. Some indication of the laboratory's activities will be indicated by a summary of recent work.

Lockheed has completed contractual agreements with various government agencies to engage in education-oriented tasks. A comprehensive training program in naval oceanography was drawn up for a federal office, the Naval Training Devices Center, which sought a curriculum suitable for a broad range of military personnel. Our assignment was to prepare a curriculum and the training aids needed to cover the field of oceanography as it related to naval operations. In another instance, Cerritos College, Norwalk needs for field trips and work at sea were met by chartering a 50 ton Lockheed research vessel. NSF funds were used for demonstrations whereby classes were taken a full day at a time into various marine sites. Members of the research staff used conventional oceanographic instruments, engaged in actual operations, and showed work techniques used by practicing oceanographers. Classes from San Diego City College and Southwestern College likewise were allowed to see work in progress at the laboratory and on the waterfront.

A particularly effective teaching situation has been developed with the latter two colleges named. Last semester one of our scientists taught day classes at San Diego City College in the new subject area "Marine Technology." This transfer of the industrial scientist from his laboratory into the classroom helps in bridging the gap between the deck of the research vessel and the student's desk. Southwestern College is using a Lockheed marine scientist to aid in preparing a two year curriculum which will materially assist in producing competent technicians.

The industrial scientist maintains close connection with the museums in his locality. For instance, one of our scientists participates in the activities of the San Diego Museum of Natural History both by qualifying as a Research Associate and also as a museum docent. In this way the regular museum staff and the laboratory scientist staff can augment each other. Collections made in place by the Lockheed research submarine "Deep Quest" down to depths of eight thousand feet will be contributed to the museum's depository of local biota and sediments.

Colleges' and education departments' advisory panels are continually in need of industrial marine representatives. In this larger cirlce of community inter-relationships, the industrial laboratory scientist can join the educator on common ground. A Lockheed scientist serves on advisory committees for marine technology with the State Board of Education, Fullerton Junior College (since 1965), as well as Southwestern and San Diego City Colleges.

From the slides, you will get a general overview of the facilities of the Lockheed Ocean Laboratory. Certain of these are typical of the equipment used by the marine technicians. These are used in training under actual working conditions. We consider it most important that technical personnel have a good understanding and appreciation of the marine environment, resources of the sea, and the operations involved in exploiting those resources.

THE ROLE OF EDUCATION IN THE FIELD OF OCEAN SCIENCE

THE ROLE OF EDUCATION IN THE FIELD OF OCEAN SCIENCE

by

Tommy Thompson
Public Relations
U. S. Divers Company
Santa Ana, California

I would like to speak to you today on the subject of education in industry, more specifically, education in the field of ocean science industry, the one that I am more familiar with.

May I quote from recent help wanted classified ads in a local Orange County paper, "Help wanted. Orange County company needs graduate mechanical engineers to work in the field of ocean engineering on such projects as controls, purification, metering, valves and piping for deep diving vehicles and the life support equipment for aquanauts;" "Wanted, chemical engineers to work with dynamic Orange County company in the field of life support equipment in such interesting projects as nuclear submarines and research vehicles."

The above are only a few of the "help wanted" ads that appear daily trying to procure the services of personnel with an education to work in the field of what we so-called experts call the "Ocean Sciences."

What are we speaking of in the amount of money to be spent in this underwater world? From the Los Angeles Times of only yesterday, "Tripling of a current 8 billion investment of west coast ocean industrialization was forecast today by economic experts. California Business said private investors are 'coming in' to projects for exploration of oil, gas, chemicals and food in addition to the recreation as ocean-productive aims." Also from the Los Angeles Times, a full-page ad from Merrill, Lynch, Pierce, Fenner and Smith on information in regards to investments in ocean industries. Another publication which forecast the challenge and opportunity in the field of oceanography.

The Chairman of the Board of Directors for the company that I work for is a very famous man in the field of the ocean science, Captain Jacques Cousteau. Almost daily I get letters addressed to Captain Cousteau from young boys and girls just like your students. These young people are all asking the same thing, "How can I become a diver and work with your Company?" I send practically the same answer to all of them, get an education! Regardless of what field you desire, an education from A to Z - accounting to zoology, we can use you in the ocean science. I can make a diver out of most everyone. If I put enough weight on them, they will go to the bottom of the ocean and I will get most of them back; but in order to accomplish something and earn these fantastic wages we hear of, a person must be able to accomplish his given task while on the bottom, regardless of what it is from A to Z. Therefore, an education is necessary.

Then I request you as the educators of Orange County, please use all of your influence and pursuasion to keep the young people in school, make sure they get the best education possible before they come to us in industry.

MARINE ECOLOGY FOR THE FIVE YEAR OLDS

MARINE ECOLOGY FOR THE FIVE YEAR OLDS

by

Charlene MacDonald
Margaret Pratley
University Park School
Irvine, California

"Hi there Old Fuzzy Chest," exclaimed Paul while watching the hermit crab preen his antennaes.

"Look. Did you see? The little Herbie just changed shells," said Christy as a small hermit crab crawled into a new shell.

"The shrimp's out; Old Charlie chased him. He's scared." yelled the children when the large edible crab frightened the shrimp.

"The shrimp died," said Keith seeing a white skeleton in the aquarium. Then from behind the rock the shrimp slowly emerged in his new red shell. "You tricked us," laughed David. What really happened: "He changed skins just like a lizard," answered Danny.

HOW IT ALL STARTED

What prompted such dialogue in the Kindergarten? We must go back to the beginning. One day in room 20 at University Park School some of the five year olds shared their exciting beach outing of the past weekend. The ensuing discussion aroused a desire in the children to know more about this area so close to our doorstep.

Soon thereafter, an item on the faculty bulletin board caught our eye: "Mr. Ron Linsky, Coordinator, Marine Sciences announces the opening of the Orange County Onshore Marine Laboratory at the Balboa Pavilion for children in grades K-12." It sounded perfect for our purposes, so arrangements were made and our classes embarked upon a field trip that proved to be the impetus for one of the most exciting learning experiences we can recall.

The children were captivated from the moment they walked into the world of marine ecology. They were encouraged to use all their senses in their introduction to this world of the sea. We never heard, "Don't touch!" rather, "Look, feel this, smell it, feel the thornback shark." The shark had been caught that morning on the Offshore Laboratory boat used for the older children in the county. We smelled, touched and observed anchovies, gobies, decorator crabs, rock shrimp, an elbow crab, sea stars, and a myriad of shells of every variety. The children's favorite was the hermit crab. They named him Clown as the crab played hide and seek, retreating into his shell or emerging when his courageous moments moved him. From the wharf outside we watched a fishing boat loading its bait, and we learned the names of a half a dozen shore birds as they flew close to us in their search for food. When we left, Mr. Linsky's last words were, "If you can get a container that will hold salt water I will be happy to bring you some live specimens!"

SALT WATER AQUARIUM

Could we really have our own salt water aquarium? With the advice of some experienced aquarists we did establish one[1]. Then we anxiously awaited the arrival of the promised specimens.

It was our red letter day when Mr. Linsky entered with plastic bags containing sea life. Excitement ran high. The first tenant was our very own "Harry, the hermit crab" as he became known. A beautiful red rock shrimp went sailing to the top of the aquarium and drifted downward with all legs fluttering. A bright yellow nudibranch quickly attached itself to the side of the tank while a small goby fish lurked among the rocks and seaweed. That was just the beginning of our salt water community.

The children collected some small hermit crabs and snails to help balance the aquarium. We teachers set out with net and bucket to the Laguna tide pools. What a harvest! We found a small sea anemone secured on a rock with seaweed and limpets attached. Another find was a loose rock with a barnacle colony and a chiton. In addition we collected three opal eye fish and two rock fish. All of the specimens readily adjusted to their new environment.

Twice a week we shaved frozen fish filet into the tank and our friends eagerly devoured their tasty treat.

Our activity hour was always marked by one or more faces close to the glass observing the ever changing scene that was developing within that watery enclosure.

---

[1] Fish store personnel are most willing to give recommendations and helpful hints to aid in the establishment and maintenance of the aquarium

CHILDREN'S RESPONSE TO THE AQUARIUM

The presence of the aquarium in our room elicited daily responses from the children that we never dreamed possible. Their natural curiosity led to extensive research in and out of school. Together we discovered many interesting facts about our sea animals. One day we noticed fewer barnacles sweeping the water for food. Research informed us that rock fish thrive on tender barnacles, and shortly afterwards we observed the rock fish feasting on them.

Language Development - The children's vocabulary multiplied rapidly as their thirst for knowledge increased. Daily we shared our observations of the aquarium and other related experiences. The children's enthusiasm was spilling into their family lives and Saturday excursions to the tide pools became vogue.

The children drew pictures of their fascinating friends for thank you cards, get well notes, and illustrations for the room. They dictated their original stories to accompany them. Our color chart is a large portrait of Harry, the Hermit crab. Around him are colored fish with their color names printed on them.

Music - The interest was so keen that we integrated oceanography into our entire daily program. During body rhythms the classroom was transformed into an imaginary ocean with many different animals swimming and flowing about guided by background music from the piano and auto-harp. The children individually planned the best way for them to portray the movements of their chosen animal. Watching arms and legs gently sway then clamp up tight as the sea anemone trapped some food was most delightful. If one was doubtful as to the appropriate movement, immediate observation of the animal was available in our aquarium.

Art - Our art work was a joy, and the possible projects seemed endless. We hand painted a large undersea mural which was inspired by the excellent film "Sea Adventures of Sandy the Snail." The children used various painting techniques to illustrate and cut out a multitude of sea animals that lived in the hand painted water. The crayon resist theory provided lovely undersea pictures. We also stuffed and laced together our own created "blotto" fish which hung from the ceiling. Adventures in mixing colors at the easel and hand paints to make ocean colors were exciting for everyone. Delightful sea animal replicas were made with pottery clay and painted when dry.

Math - Mathematical concepts were reinforced with many independent activities. For example -- 1:1 matching shells with pictures, grouping pictures of sea animals into three categories - 1) Fish, 2) Shell animals and, 3) Animals without shells and making comparisons during observations about likenesses and differences in our sea animals. Opportunities for counting continually presented themselves in and around our aquarium - the crab and shrimp's legs, number of animals with shells, which three friends are the largest and the smallest, etc.

When introducing the calendar in our room, the children displayed pictures of sea inhabitants in a pocket chart to represent each day of the week. The hydrometer and the thermometer readings, which gave us a close estimate of the salinity of the water, introduced new learnings to the children.

Outdoor Activity - Our marine theme was even applied outdoors to our organized games. The traditional running game of Squirrel in Tree became Hermit Crab in Shell; Red Rover was easily adapted with the name of sea animals to come over when called; Duck, Duck, Goose was changed to Crab, Crab, Shrimp; Scat, in which children imitate clown actions, was revised to use movements of the sea animals.

From our experiences we discovered that marine ecology was adaptable to our entire kindergarten curriculum.

REINFORCEMENT OF LEARNED CONCEPTS

Many children had been bringing in shells from their parent's collections or from weekend excursions to the local beaches. We decided that each child should have his own collection so our next field trip was planned. The destination was a beautiful wide beach on the Balboa Peninsula where there were shells galore. The expedition to the beach brought the children into an environment that exposed them to other marine conditions. Standing on the jetty adjacent to our collecting area, we watched some men fishing, a sea star clinging to the rocks, a rock crab scurrying for cover, and some boats going in and out of the harbor.

Now we each had our personal shell collection and in the following days we were busy sorting the shells and gluing them to heavy cardboard to take home. The children identified the shells with the help of our reference books. The reading readiness values here are obvious --- looking for likenesses and differences, categorizing, and left to right progression. The whole process was satisfying for the children.

Throughout this study we ordered several excellent films from the Orange County Schools Audio-Visual Center which were shown periodically to our classes.[2] We found some excellent books in our school library which we arranged for the children to peruse.[3] In addition, the children brought many good books from their home libraries; consequently we did not lack reference material.

After some time had elapsed, we decided to get out once more for some fresh ideas and a different look at this big ocean; heretofore unknown to us except for frolicking in its waves and building sand castles on its shores. Since we had become acquainted with some of the things living in the sea we next planned a boat ride on the Newport-Balboa Bay and out into the Pacific Ocean. Not only did each child get to steer the boat, but he learned some of the nomenclature that would help to free him from the landlubber category. Our captain showed us a Coast Guard boat and pointed out some of the safety and rescue devices on it. We saw buoys of many varieties and learned their different uses. There were fishing boats, barges, ferry boats, a fire boat, gulls and ducks bobbing on the waves of our wake, and we even heard the low, mournful fog horn warning the ships at sea of the rocky jetty ahead. With this trip the children were able to identify more with the sea. They were learning another aspect of the ocean and its dimensions were beginning to seem unlimited!

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[2] See bibliography

[3] See bibliography

Spring vacation rolled around and the family of one of the teachers spent the day in San Diego. They visited a friend who was a marine biologist and a collector of marine life for Scripps Institution of Oceanography. With the inevitable exposure to the Vaughan Aquarium at Scripps, another field trip was formulated for our kindergarten. The aquarium provided a perfect atmosphere for our children to reinforce the concepts learned and to get excited all over again about the inhabitants of the sea, if in fact their interest had ever flagged. This of course was to be an all day affair; rare for kindergarten but certainly not unheard of. With the approval of administration and parents we went ahead with plans. The children took the long day beautifully, and their delight in the aquarium itself was a pleasure to see. Their verbalizations were a bit staggering to the adults that were leading the tour. One adult exclaimed, "These are only five and six year olds? Why, they are asking more intelligent questions than most adults!" The children were able to identify sea anemones, rock fish, abalones, limpets, shrimp, lobsters, sea urchins, opal eye fish, sharks, sea cucumbers, and rock and hermit crabs. There were only two types of fish in the entire aquarium that the children were unable to recognize; groupers and flat fish. We lingered long at each tank excited about the old friends we were seeing. Our exposure to them in our own aquarium and through our research was invaluable. The new things we saw were of great value as well, and it is difficult to imagine that these children will ever completely lose their interest in the sea and its inhabitants.

An Open House marked the culmination of this area of study. The parents all remarked on how much they themselves had learned from their kindergarteners throughout this year and how amazed they were at the fund of knowledge acquired by their five and six year olds during their first year of schooling.

Our salt water aquarium will not be dismantled but will remain for the balance of the year with some new additions. We have given consideration to introducing a sea urchin and/or a small octopus to the children. It would be unthinkable not to have our marine friends with us. They are as much a part of our classroom as the piano and the blocks!

We like to reflect on the possibility of the potential marine biologists that just might have been born this first year of their formal education.

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Sea Adventures of Sandy the Snail - F2452

Sounds in the Sea - F2290

Seashore Oddities - F2143

Flight of the Seabirds - F537

*Numbers refer to catalog numbering system in the Orange County Audio Visual Center.

A UNIT ON WHALES FOR PRIMARY GRADES

A UNIT ON WHALES FOR PRIMARY GRADES

by

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OBJECTIVES

To provide a marine science unit that actively involves the children and gives them a general background of whales.

FACTS AND RELATED ACTIVITIES

A. Whales are mammals. They breathe air and are warm-blooded. Their babies are born alive and they nurse them with milk.

Activity Compare the breathing to the way the children must hold their breath when they go under water.

B. Some adult whales are the largest animals alive.

Activity Compare the whale's length to something near the children, such as the school building. Take them out and measure the length of a whale on the playground. Another good comparison is if a whale stood on its tail it would be as tall as ten elephants on top of each other.

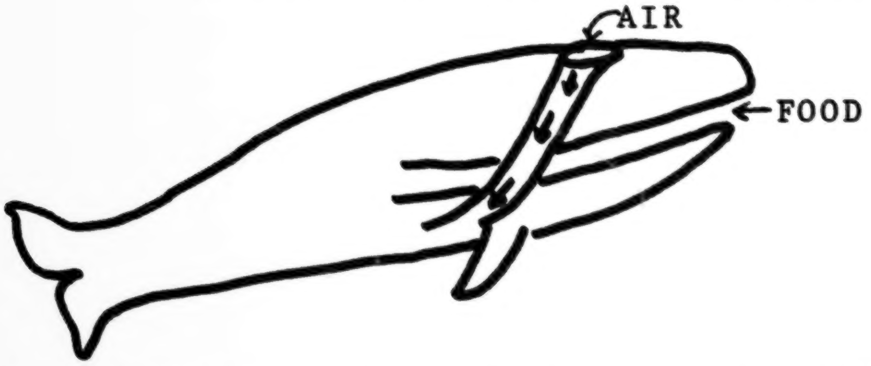
C. The tail or fluke of a whale moves up and down and gives the whale speed.

Activity Bring a fish into the room so the children can see a vertical tail which moves sideways to contrast it to a fluke.

D. The nostrils, or blowhole, are on top of the whale's head. The warm air in the whale's lungs is exhaled through the blowhole.

Activity The children can compare the water vapor to the way they can blow "smoke" when they walk to school on a cold morning.

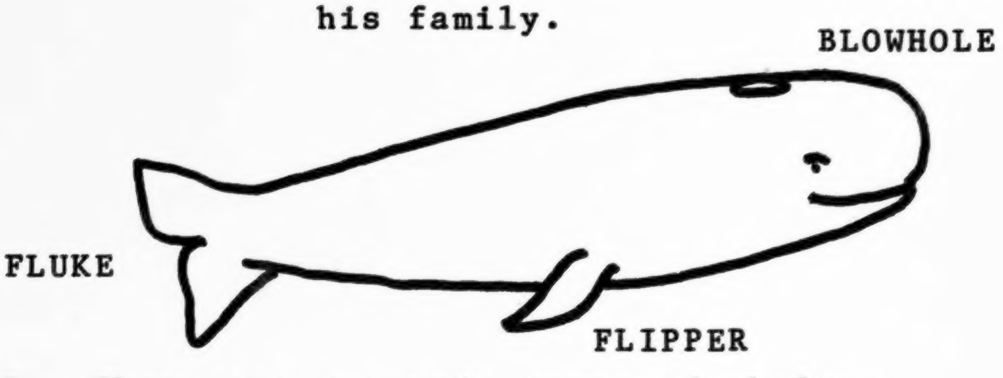
Activity The children can make a diagram of a whale to show the process of breathing.



E. The whale uses a pair of flippers for balancing and steering.

Activity Compare the flippers to a person in a rowboat using the oars to row and turn.

Activity Have the children draw a large whale on paper and label the parts of it. Let the child take it home that day to relate to his family.



F. There are two main types of whales.

1. Baleen Whales. Instead of teeth they have sheets of baleen in their mouth. It acts as strainers.

Activity You can compare the baleen as a substance similar to their fingernails.

a. Gray Whales. The Gray whale migrates from the North Pacific to lagoons in Mexico. They go to the warm waters of Mexico to have their babies.

Activity The children can make a class map showing the route of the Gray whale.

2. Toothed Whales. These whales have true teeth that are used mostly for gripping.

Activity Have the children divide a paper in two parts and draw pictures showing the difference between baleen and toothed whales.

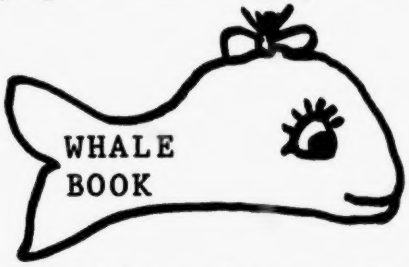
ART

A. Clay Whales. Have the children work the clay into a rounded, oblong shape and pull on the clay to make the fluke and flippers. Then follow regular clay procedure for firing.

B. Three-Dimensional Whales. The child draws a large whale - cuts it out - and uses it for a pattern to draw another. Put the two whales together and staple around the edges. Then stuff with shredded newspaper.

LANGUAGE EXPERIENCE AND READING

Read make-believe and true whale stories to them and then let them write one of their own. Have them write it on whale shaped paper and combine it into a book.



Encourage the children to read books on whales. There are several published on their level. Have them collect pictures of whales and as a class project, write the narration for a story. You can combine reading and art by giving each child written directions on what to paint in a picture about whales.

CULMINATION

As a culmination for the unit you can have someone acquainted with the marine sciences come in and speak to the children and show pictures. I asked the coordinator of marine sciences for my school system.

VOCABULARY

whale
baleen
blubber
breaching
flippers

fluke
harpoon
mammal
spout
water vapor

hyperventilation
lagoon
Alaska
Mexico

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Wheat, G. Collins. Whales and Dolphins. Golden Press
Winnie. Dell Publishing Company
Zim, Herbert. The Great Whales. Scholastic Book Services

EVALUATION

I have written some of the facts and how I presented them to the children. The most valuable part of this unit was the interest the children showed in finding information on their own. They took their diagrams and work home and explained it to their families. Then they used the library and newspapers to bring interesting items to the class. There is rarely a week that goes by now when the children don't compare something to a whale - or color one - or write about one.

MARINE BIOLOGY AS CURRICULAR ENRICHMENT

MARINE BIOLOGY AS CURRICULAR ENRICHMENT

by

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The proper utilization of marine resources is dependent upon the degree of knowledge and involvement possessed by the future adults. These people, our present students, should have the opportunity to learn about the oceans as early as possible when their interest is at its peak. We have seen how teachers in the elementary schools are making real strides in reaching the younger children. As this keen interest does not diminish through the years, marine sciences at the high school level provide excellent opportunities to stimulate more interest in biology, chemistry, physics, earth science and all branches of science.

Oceanography can be taught in the secondary school as a unit in any of the standard science courses or as a separate program presented in the summer when longer time blocks are available. Marine science should be an integral part of any science offering, but the summer program greatly enriches the overall science curriculum.

In 1962 the Huntington Beach Union High School District set about to develop a course in Marine Biology. Thanks to the spirited efforts of Ronald B. Linsky, then a biology teacher in our district and now director of marine sciences for the Orange County Schools, a fine program was begun. During the summer of 1963 one section of the course was offered as a pilot program. The success of Marine Biology has been shown by the steady increase in student interest.

There have been changes and modifications in the program since the embryonic years, but the basic objectives have been retained:

1) to increase the students' awareness of the ocean and its biota;
2) to add a dimension to the science program through the use of extended time blocks;
3) to understand the ecological relationships and the role played by all organisms, large or small;
4) to develop within the students feelings of the importance of conserving our marine resources.

To maintain a smooth operating program, it was necessary to limit the class size to 30 students. Larger classes have proven to create more destruction to the habitats than the percentage increase would warrant. We feel that four sections of marine biology in our district should be the maximum permitted, but the great interest in the students has presented problems. We are now forced to select the students, if we are to prevent a fine program from self-destruction. Some criteria for selection could be:

1) students who will be seniors;
2) students with known marine science interest;
3) high ability science students.

EQUIPMENT
(for a class of 30 students)

The greatest financial investment in the program is for initial equipment and newer and improved instruments as they are developed. Much of the needed equipment will be found in the existing science department of the school. Such items would be: microscopes, dissecting equipment, aquaria and accessories, chemical equipment and glassware. A partial list of equipment and materials ordered special for Marine Biology includes:

1) seines 6 (10 to 25 foot)
2) dip nets 12
3) plankton tow net
4) enamelled trays 12
5) bottle forceps 12
6) many 1 gallon wide-mouth jars, both plastic and glass (We had a near serious accident on a reef once while using glass containers. As a result, no glass bottles are permitted on rocky areas)
7) various sizes of museum jars
8) many baby food jars

   both 2 and 5 gallon plastic carboys, with and without spigots
9) plastic buckets 12
10) chemicals: formaldehyde, isopropanol, chloretone, and silver nitrate

REFERENCE MATERIALS

We utilize all possible sources of reference. There are, as yet, no really good texts or syllabi for secondary school marine science. Syllabi developed for local programs, such as the one used by the Orange County Floating Marine Laboratory, have limited use in any other program, but do make excellent references. The teacher of marine science must make use of all sources. Most people, we have found, were more than willing to share their ideas with us. We have obtained keys, outlines, laboratory activities and other ideas from local universities, colleges and California Department of Fish and Game, which we have included in our program.

In Marine Biology we use several books as standard references; partial listing follows:

Coker - This Great and Wide Sea - basic text.

Dawson - How to Know the Seaweeds.

Hedgpeth and Hinton - Common Seashore Life of Southern California - basic field reference (The students must buy this fine little book, most do so in order to have a reference when they finish the program.)

Light, et al - Intertidal Invertebrates of the Central California Coast.

MacGinitie and MacGinitie - Natural History of Marine Animals.

Miller, et al - A Field Guide to Some Common Sport Fishes of California.

Rickets and Calvin - Between Pacific Tides - basic lab reference.

We do use other references and are always looking for additional materials which would prove useful in a ecology-oriented course.

PRE-SEASON PLANNING

We hold several staff meetings each spring prior to the start of the program. There are many things which must be carefully worked out: 1) field trip schedules; 2) film schedules; 3) content planning and revision and 4) laboratory and field study activities. Each year these planning sessions take on greater and greater importance as more sections and teachers are added to the program.

COURSE CONTENT

Marine Biology is designed as a one year laboratory science class. The first two hours are designated as lecture and the second two hours are assigned to laboratory work. As this is a field-oriented class, we devote much more time to the lab-field work than we do the lecture-discussion periods.

In the lecture we present the basic oceanographic information and biotic interrelationships. A very brief outline follows:

I. Physical properties of the ocean (as they influence life)
II. Geological features of the ocean
III. Water currents and movement
IV. Biotic interrelationships
V. Food producers
VI. Food consumers
VII. The ocean in man's present and future

This outline is continually modified. Each teacher works out his/her program within the basic framework of the outline developed by the staff in the spring.

The students are expected to participate freely and often in the lecture/discussion sessions. In addition, each student is required to carry out independent library research in some aspect of marine science.

The laboratory activities are designed to enable the students to learn the marine organisms, the physical factors which influence them and the ecological interplay between the organisms and the ocean environment.

Each student is expected to carry out an experimental project in which they design the work, perform the experimentation, gather data and prepare a formal report on the results of their work.

LABORATORY

The students devote many hours to post-field trip work and various laboratory activities. Each field trip is followed by labs in specimen preparation technique and species identification. We perform many different experiments on the chemistry and other physical properties of sea water. Other exercises are carried out on the physiology of marine organisms.

USE OF COLLECTIONS

The use of collections has great value in a field-trip-type course, yet each collection adds to the drain on the shoreline biota. We have made every effort to minimize the capture of marine organisms, but have felt that one must use fresh material to learn to identify species, proper preparation techniques and the study of anatomy to see how these organisms are adapted to their environment. We do devote the greatest possible efforts to the study of the specimens as living creatures in their natural habitats. Now that our study collections are in pretty good shape we can use more of these prepared specimens in the lab prior to going into the field. We will continue to take species from Newport Bay for two reasons; (1) so many of these are doomed with the planned "improvements" of the upper bay and (2) we can give the students an opportunity to practice specimen preparation.

FIELD TRIPS

As field trips are the heart and soul of Marine Biology, all of our activities are designed to prepare for the trips or to utilize the information obtained in the field. We plan six field trips for each class. On these trips we attempt to make available to the students every marine littoral habitat that is accessible. As the number of available habitats diminish and the enrollment in our program increases, arranging the trips is becoming increasingly difficult.

To facilitate the field work, we divide each class into six squads of five students each with a squad leader in charge of the team. Recorders, cartographers, chemists and chiefs of supply are appointed in each squad.

While carrying out his field work, each student is required to maintain a field data book in which observations made on the trip are carefully recorded. (Figure 1 is an example of the field data sheet we have developed for the program).

In addition to the standard data, each student is to record his observations of certain ecological conditions particular to the area being studied. After each trip the students submit a report based on their studies.

In the past years, the first trip has been to Marineland of the Pacific. The purpose of this trip is to introduce the principles of ocean life by using living examples. This is not a mere tour of the shows as the students make a series of studies which require considerable thought and keen observation.

Before undertaking our first "wet body" field trip the students study the important indicator species and the ecological factors of the habitats to be examined. (Figure 2 is a partial list of the field trip rules which are strictly enforced. The teacher and the students develop these rules together).

Last summer we made three separate trips to rock coast areas (Palos Verde and Scotchman's Cove, north of Laguna Beach) and two trips to Newport Bay. Time permits me to give only brief sketches of two of the trips we made last summer.

PALOS VERDE

The area around Paddleboard Cove was used as the first shore study as it had every type of open coast habitat found locally. Before the students made the trip the staff examined the area and planned the various activities the students would carry out. A time table was worked out so that each class could take advantage of the most favorable conditions.

When the students arrived at the site they studied the entire area from a vantage point to get the overall picture of the various habitats. They got to the water 1/2 hour before the change of tide in order that they might follow the water out, studying the zonal changes as they went. After the general data had been collected the students began to work on their individual studies. Each student was required to study one animal species in detail and record many different relationships. (Figure 3 lists some of the observations necessary for this trip).

On this first trip the students had to be coached very carefully on proper safety precautions, observation techniques, and what to collect. Most were very excited and wanted to study only the "flashy" species. We had to stress that fish and octopi were not the only forms of life in the sea. The students were instructed again and again to consider the biota of the reef as a whole and to understand the role of all species. At this time it was important to drive home the need for proper conservation practices as the first trip would set the pattern for the entire summer.

After about three hours the kids were tired so we held a critique on the beach, discussing the various interrelationships seen and studied.

NEWPORT BAY

We have stressed this area for several reasons: 1) it is close; 2) we can find many different ecological conditions and 3) it presents an important conservation lesson. On these trips to the mudflat marshes the students got a real TASTE of an environment. Not all of the students were thrilled by the back bay ooze, but all had to admit that they had a rare experience. On the trips to the upper Newport Bay we studied the open channel, the mudflats and the salt-marsh islands. (Figure 4 shows a list of the equipment we took on these trips. Although the type of work on the bay trips was somewhat different from that on the open coast trips, much of the equipment is standard for all field study).

On our bay trips we tried to demonstrate several things to the students: seining techniques, role of the substrate and other factors on estruarian life, and a complex food web. (Some of our activities are seen on Figure 5). In addition to these tasks, the students were asked to compare the fauna and flora of the back bay with those of the open coast.

After the back bay trips we worked at the Orange County

Onshore Marine Laboratory. Located in the Balboa Pavilion, this facility was opened last summer. Developed by Davey's Locker, the Orange County Schools and our school district, the Onshore Lab makes it possible to study many bay and open ocean organisms firsthand while still alive. (Figure 6 is a brief replica of the student's assignments for one of the trips to the Onshore Lab).

The plans of an enrichment program such as Marine Biology are always ambitious and somewhat idealic. Not all students were able to accomplish the various requirements as completely as we would have wanted, but many of them did, and we feel that the majority of the students do gain a great deal from the program. After working with eager, over-eager, and "jazzed-up" students for six weeks, the staff arrives at the close of the program with tired bodies, but with light and happy hearts.

FIGURE 1

MB FIELD DATA SHEET

Date ____________________ Time ____________ Collection # ________

Locality ____

____

Map # ______________ Lat ______________ Long ______________

Tide: L ____________ Time ____________ H ____________Time______

Water Temp __________ Air Temp ____________ Water Temp __________

Wave Action _________________ Turbidity ____________________________

Habitat ____

____

Substrate ____

Vegetation ____

Method (s) of Capture ____

Species List and General Notes

FIGURE 2

MB FIELD TRIP RULES

THE FOLLOWING RULES MUST BE OBEYED WITHOUT EXCEPTION:

1. NO STUDENT IS TO WORK ALONE
2. NO RUNNING ON TRAILS OR ROCKS
3. NO CUTTING TRAIL
4. NO GLASS CONTAINERS ALLOWED ON ROCK AREAS
5. NO SWIMMING NOR SCUBA DIVING
6. NEVER GO BAREFOOT
7. HANDLE ALL UNFAMILIAR SPECIES WITH CAUTION
8. USE CARE WHEN PLACING HANDS UNDER ROCKS
9. HANDLE ALL CUTTING TOOLS WITH CARE
10. NO COLLECTION OF ORGANISMS PROTECTED BY LAW. HOLD COLLECTING TO A MINIMUM
11. REPLACE ALL HABITAT FEATURE: TURN ROCKS BACK, COVER HOLES, ETC.

OBEY ALL ORDERS AT ONCE!!! REPEATED VIOLATIONS WILL RESULT IN EXPULSION FROM THE PROGRAM.

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FIGURE 3

ROCKY COAST HABITAT ASSIGNMENT

(EACH STUDENT IS TO SUBMIT STANDARD FIELD DATA IN THE REPORT AS WELL AS STUDY OF ONE ANIMAL SPECIES IN DETAIL).

ORGANISM STUDY (ANIMAL)

1. SCIENTIFIC AND COMMON NAMES
2. CLASSIFICATION AS COMPLETE AS POSSIBLE
3. PHYSICAL DESCRIPTION INCLUDING DRAWINGS
4. ASSOCIATED SPECIES
5. HABITAT: ZONATION, SUBSTRATE, EXPOSURE, ETC.
6. METHOD OF LOCOMOTION
7. REACTION TO OTHER ORGANISMS
8. FOOD HABITS
9. REACTION TO EXPOSURE
10. REACTION TO WAVE SHOCK

LIST THE TWO MOST IMPORTANT INDICATOR SPECIES IN EACH ZONAL AREA.

FIGURE 4

EQUIPMENT FOR A FIELD TRIP (MARSHLAND)

EQUIPMENT FOR EACH SQUAD:

1. SEINES AND DIP NETS
2. COLLECTING BOTTLES AND VIALS
3. FORMALIN
4. FORCEPS ·
5. THERMOMETERS
6. WATER SAMPLES BOTTLES
7. PLANKTON NET AND SAMPLE BOTTLES
8. METER STICKS AND METRIC RULES
9. SHOVELS AND OTHER DIGGER TOOLS
10. SCREENS
11. FIELD TAGS
12. FIELD BUCKETS

EQUIPMENT FOR EACH STUDENT:

1. FIELD DATA BOOK
2. RAPIDOGRAPHIC PEN AND HIGGINS INK
3. FIELD SHOES AND CLOTHES, CHANGE
4. FIELD IDENTIFICATION BOOK(S)

OPTIONAL EQUIPMENT:

1. BINOCULARS
2. FOOD

FIGURE 5

MB FIELD DATA FOR MARSHLAND HABITAT

1. DESCRIBE DISTINCTIVE GEOPHYSICAL FEATURES. SKETCH ON MAP.
2. INCLUDE THE FOLLOWING DATA FOR EACH HABITAT: SUBSTRATE, TEMPERATURE, WATER DEPTH, WATER TURBIDITY.
3. SPECIES LIST FOR EACH HABITAT.
4. PLANKTON STUDY: 2 TOWS; SAVE ONE FRESH AND ONE PRESERVED SAMPLE FROM EACH TOW; RECORD DATA FOR PLANKTON DENSITY DETERMINATIONS.
5. STUDY MUD FLAT ORGANISMS. RECORD SPECIES AND DENSITIES IN DIFFERENT SUBSTRATES.
6. SEINING OPERATIONS. FOLLOW INSTRUCTIONS; RETURN FISHES TO WATER AFTER COUNTING; RECORD NUMBERS, MIN. AND MAX. LENGTHS AND ANY FIN TAG DATA.
7. LOCATE ALL CREW COLLECTION STATIONS ON MAP BY NUMBER.
8. LIST THE BIRDS AND MAMMALS SEEN; DESCRIBE THEIR ACTIVITIES.
9. PREPARE A PROBABLE FOOD WEB OF THE MARSHLAND; INCLUDE AT LEAST 8 SPECIES STUDIED IN THE FIELD.

FIGURE 6

MB ONSHORE LABORATORY

1. FISH ANATOMY - STUDY THE EXTERNAL AND INTERNAL ANATOMY OF FRESH FISH FROM THE LIVE-BAIT TANK.
2. FOOD OF FISHES - DISSECT THE STOMACH TO DETERMINE WHAT THE FISH HAS BEEN EATING.
3. FISH PARASITES - EXAMINE THE GILLS, FINS AND INTERNAL ORGANS FOR PARASITES. IDENTIFY, IF POSSIBLE.
4. GROWTH OF FISHES - EXAMINE THE SCALES FROM DIFFERENT SPECIES; ATTEMPT TO DETERMINE AGE AND GROWTH PATTERNS.
5. PILING AND FOULING ORGANISMS - COLLECT DIFFERENT SPECIES FROM FLOATS, PILINGS AND BOATS. IDENTIFY AT LEAST TO PHYLUM. LOOK FOR, AND RECORD EVIDENCES OF SYMBIOSIS.
6. PLANKTON STUDY - MAKE MEASURED TOW FROM SMALL BOAT; EXAMINE SAMPLES WITH MICROSCOPES. PRESERVE A SAMPLE FOR FURTHER STUDY. RECORD MEASUREMENT DATA; COMPARE DENSITIES WITH OTHER HABITATS STUDIED.

THE OPENING DOOR: OCEANOLOGY
AN ESSAY ON MARINE SCIENCE CURRICULUM

THE OPENING DOOR: OCEANOLOGY

AN ESSAY ON MARINE SCIENCE CURRICULUM

by

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In an address presented on July 13, 1966, President Johnson took note of the importance of oceanology. He portrayed our newly awakened scientific interest in the sea as "a new age of exploration" and described the high adventure that still awaits those pioneers who enter upon "our last frontier on earth." Addressing himself in particular to a group of young high school students, the President stated, "I hope that there are among you some of the great oceanographers of tomorrow. You could not choose, in my judgment, a more important or challenging career."

The growth potential of the total field is clearly indicated by the amount of money spent by sea people today - variously estimated at between $\$3 - 48 \times 10^9$, and the hundreds of billions estimated by 1975. Whatever its magnitude, the amount is growing and it will continue as oceanologists are expanding their limited knowledge of the ocean.

What a fantastic opportunity awaits our present and future young students to be in such a position as to be in on the opening of a whole new field of study!

No one can predict the importance of oceanology in the future. Further, the areas of study are so numerous that trying to chart a course of study through these virgin waters is most difficult. In developing my course in Physical Oceanology I had no success locating any existing curricular guides. Therefore, an attempt was made to build a program around a few broad concepts that seemed to cover at least in part the disciplines most often covered in university programs.

A logical first unit might be the History and Discovery of the Oceans. A chronological sequence dating from Egyptian and Greek times should be considered. The Odyssey might prove an interesting auxiliary side light. Next, possibly, the Indo-Pacific migrations might be studied. The role of currents and the populating of the Pacific Islands could be related to the modern adventures of Thor Hyderdhal and his raft, the Kon-Tiki.

Historic figures such as Columbus, Balboa and Cook, early scientists such as Maury and Nansen, could be studied for their contributions in exploration, discovery and navigation of the oceans.

In more recent times, Piccard and Cousteau, as well as nuclear submarines, Sea Labs I, II and III, the Star House in the Red Sea, make exciting study. Spin-off from the above could make for very fruitful classroom discussions in a variety of areas in marine science.

A second area of study might be called the Physical Propperties of the Seas. Depending upon the ability level, in-depth discussions of such topics as salinity, temperature, and pressure are a necessity. The biological implications of upwelling, populations and various ecological relationships could also be brought up.

Other physical parameters of importance are density, transparency, color and electrical conductivity of sea water. All of these areas can be applied to the laboratory situation. Also, freezing and boiling points, salinity and electrical conductivity experiments can be performed with a minimum of laboratory equipment.

The relationship between water temperature and oxygen content can be approximated by merely counting the gill movements (breathing of fish) at differing temperatures. This simple experiment could lead to more complex ecological relationships such as the proper temperature affinity of the Blenny or other tide pool animals. By chilling one side of an aquarium and heating the other side, a rough temperature gradient can be established. The "most pleasing" temperature as far as a Blenny is concerned can then be approximated.

A third unit could be entitled Rivers in the Sea. Introduction of this topic can be accomplished with a humorous historical flashback to Ponce de Leon. In brief, he probably had the dubious honor of being the first captain to sail backwards with sails full of wind. He was sailing off the coast of Florida when he entered the Gulf Stream. The current was stronger than the push of the wind, causing the ship to sail backwards.

In this same vein, to mention Ben Franklin's subsequent discovery of the Gulf Stream seems appropriate. Using information that Yankee sailing vessels coming from England traveled a longer route, but still beat English ships by a significant margin; he reasoned that the English ships tried to buck a current of water. By comparing ships' logs, he was able to plot the path of this river in the sea.

The relationship between the sun's energy and the production of the major wind belts should also be talked about. The world's winds provide the driving force for the huge rotating oceanic currents. A brief discussion of the moderating effect of the ocean upon the world's climate could logically follow.

One of the most fascinating topics for discussion and study is the various motions of the sea: waves, surf, breakers and tides. We even try our hand at wave forecasting. A storm in Antarctica generates winds which in turn produce waves that race toward the distant shores. When will the storm waves arrive? How high will the waves be? Where would the best place be to ride the waves? All of these questions, and more, can be answered (with some difficulty, however) on the high school level.

Ripple tanks can be utilized to observe the various phenomena associated with wave forms. Refraction, diffraction and reflection can be demonstrated at most any level of sophistication. Mass transport of sand and beach erosion seem to follow nicely at this point.

A fourth unit could be called The Underworld of the Sea. Taking a step back in time to describe the ocean bottom as seen by a 19th century scientist - a flat, featureless, barren plain, devoid of all life before discussing the rapid accumulation of information concerning bottom topography is a valuable experience. How do the features such as trenches, abyssal plains, and seamounts compare to their dry land counterparts?

We also study bathymetric maps of the local coastline to locate submarine canyons, seamounts and other features of local interest. A microscopic study of the local bottom sediments will prove worthwhile, as the shapes of the skeletal remains are truly amazing. After viewing the microscopic fossil remains, discuss the book The Deep and the Past by Ericson and Wollin which describes in a sort of diary style the fascinating scientific detective work that led to the accurate dating of the last four glacial ages. The authors determined how fast sediments accumulated on the ocean bottom; then by determining the presence of absence of a cold or warm water-loving species of the plankton globigerina, they were able to correlate this information into an accurate calendar of the Ice Ages.

A final unit would probably deal with Future Resources of the Sea. A list of some of the professional and technical jobs that will be needed in the near future, when man begins to live and work on the ocean bottom, gives insight into the Pandora's box of the future. Would you like to be a future underwater weatherman; a marine rancher (a breeder of fish) who hires a porpoise trainer to herd his schools or herds of fish; or maybe a whale dairy manager? If this is too rich for your blood, how about an oceanagriculturalist or a dietician whose responsibility it is to make tasty meals from plankton, diatoms, seafood and seaweed; or an underwater mining engineer. I think I will apply for a job as an underwater recreation director for the Undersea Hilton in the Red Sea.

To just give a peek into the future, have the students break up into groups to plan, design, organize and theoretically operate an undersea city of the future then let the students go from there. Their imagination is allowed to range unchecked at first. The living space module might conjure up a wild design for an undersea community and forget all about waste removal or communications.

Then step in and bring the groups back together discussing the multitude of problems presented by the harsh environment of the undersea world.

Then, back to the drawing boards for more work within the perimeter of our knowledge of the ocean. This class project adequately ties together all the bits and pieces of knowledge accumulated during the semester's study and presents a more or less condensed view of the field.

Using the sketchy outline as mentioned, we have permeated almost every area and discipline to which the student could be exposed. We have involved the political and social sciences, all of the physical sciences and, to a lesser extent, the natural sciences. A class of this kind can't make oceanographers out of secondary level students; however, oceanology and the marine sciences are an unbelieveably perfect discipline to present new horizons, new adventures and open new doors for the future.

USES OF MARINE PLANTS IN THE TEACHING OF GENERAL BIOLOGY

USES OF MARINE PLANTS IN THE TEACHING OF GENERAL BIOLOGY

by

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The examples used to illustrate each of the following concepts may prove useful to teachers who wish to substitute marine organisms for those traditionally used in General Biology and General Botany courses. Neither the outline nor the examples are intended to be exhaustive as time permits the inclusion of only a very few of the interesting examples of biological phenomena which can be illustrated using marine plants. A bibliography is provided for those who may wish to pursue the subject in greater detail.

A. CYTOLOGY

1. Giant cells: Among the algae are to be found some of the largest cells in the plant kingdom. The most famous of these, _Valonia_, has multinucleate cells which may be an inch or more in diameter. Unfortunately, this magnificent plant is not to be found on the California coast. However, this coast does produce the gametophyte of _Derbesia_, better known as halicystis. This plant, with 1/4" spherical cells, has proved to be of great value to cellular physiologists in their study of the nature of cell membranes and the contents of vacuoles.

   It is possible to keep these cells alive after inserting a hypodermic needle into the large vacuole. An imaginative teacher or student will think of many ways to experiment with this arrangement. Another interesting plant with rather large cells is the red alga, Griffithsia pacifica, whose cells, clearly visible to the naked eye, may be 1 1/2" long but only as thick as a dime. When maintained in a weak electrical field these cells grow processes in the direction of the positive pole. This "galvanotropic" response may be due to the fact that the growth hormone (auxin) is a weak acid.

2. Cytoplasmic or pit connections: The members of the red algal subclass Florideae have more or less clearly discernible cytoplasmic connections between neighboring cells. In some algae these connections may be used to trace the pattern of cell divisions which resulted in growth. Connections are evident in the thalli of Gelidum, Polysiphonia, and Acrochaetium.
3. Cortication: This type of growth increases the diameter of the plant in a manner not found among the higher plants. This can be seen in Antithamnion and in Polysiphonia.
4. Meristems: Three forms of growth occur among algae:
    a. Large and evident apical cells are to be seen at the tips of the branches of Dictyota and Sphacelaria.
    b. Intercallary meristems may be seen microscopically in the branches of Desmarestia. The result of intercallary merristematic growth may be seen by comparing the gross structure of the single primary blades of juvenile thalli of Eisenia with adult plants whose primary blade has eroded away and has been replaced by lateral blades generated by marginal meristems.

c. Annual growth. Large, evident growth rings are to be seen in cross sections of Pterygophora stipes. Growth segments in the thallus of Constantinea are analogous to the segments between the rings of bad scale scares on some tree twigs.

5. Coenocytic thalli. Multinucleate plant bodies without septation are seldom shown to students, though they are exciting exceptions to the cell theory. The condition may be illustrated using Bryopsis corticulans, which may be collected from boat docks in quiet bays along the California coast, and by the dark green plants of the genus Codium.

Caulerpa, which does not occur on the California coast, is represented by 14 species in the marine waters of Florida, and has a complex thallus analogous to the roots, stolons and leaves of Bermuda grass, all without partitioning of the thallus into cells.

B. REPRODUCTION AND LIFE CYCLES.

Every type of reproduction, cellular union and life cycle known to occur anywhere in the plant or animal kingdoms occurs somewhere among the great variety of marine plants. Some of these types are to be found only among the algae. There is time here only for reference to examples which may be easily studied.

Pelvetia is of the Fucus group and is common throughout California. These plants have been described as having an animal-like life cycle since the only haploid cells are the gametes.

Polysiphonia is common on docks where it is a frequent epiphyte upon larger algae. Its elaborate life history was first worked out by Yamanouchi in 1906. Many botany texts have used this life cycle as though it were typical of the red algae.

Macrocystis may be used as a substitute for the illustration of alternation of generations. It is also valuable as an example of the independent development of the type of life cycle found is all higher land plants. The sporophylls of Macrocystis occur at the bases of the plants. Once recognized, they are thereafter easily distinguished from the vegetative fronds. The sporophylls may be collected and placed in a salt water aquarium with numerous microscope cover slips distributed about the bottom. Spores released from the sporophylls will settle upon the cover slips where they will develop into easily examined diecious gametophytes.

C. PHYSIOLOGY.

Marine plants are perhaps the best organisms available for the study of photosynthesis and respiration. Almost any marine plant may be used in a Gilson Respirometer equipped with photosynthesis lights and transparent bottom. Every parameter is easily manipulated except that of pressure. Variations in light quantity and quality, salinity, temperature, pH, photosynthetic and respiratory poisons, and availability of dissolved substances may each be checked and the results plotted on graph paper.

Comparative studies are also easily made between species or between plants from different depths, etc. Seaweeds contain the biggest and richest variety of pigments of any organisms. Teachers who have their students extract pigments and run paper chromatographs on spinach or grass will find the Pacific coast red alga, *Smithora naidum* well worth the extra effort required to extract its many colorful pigmanets. Anyone interested in the details of the pigment extraction process should refer to Appendix A.

Physiological investigations requiring a minimum of equipment may be made by studying the desiccation tolerances of marine plants. Here are some questions which motivated students may wish to consider. The amount of teacher assistance can be adjusted to fit the needs of the individual student researcher:

1. Do seaweeds characteristic of upper, mid, and lower intertidal have different tolerances to desiccation? How can this be answered experimentally?
   Can you plot the results of the experiment on a graph?
2. What is the comparative per cent weight recovery of various species of intertidal and bethic seaweeds?
3. How is ability to regain weight affected by hypotonic treatment? Hypertonic treatment?
4. For what period of time (hours? days?) will selected intertidal species continue to regain weight, after drying? Can the information be plotted against time?

More sophisticated students may wish to tackle the _modi operandi_ of the variables. For example, what changes are specifically responsible for the temperature effect upon the rate of respiration? Does it:

1. denature enzymes?
2. disorganize the lipid structure of membranes?
3. increase metabolism and consume reserves?
4. decrease gas solubilities and remove a critical requirement such as CO_2 or O_2?

Because so many original problems come to light while working with marine plants, students who have an opportunity to become familiar with them in the school laboratory are provided the additional excitement and stimulus of working near the frontier of human knowledge. This realization can do much to provide the encouragement and excitement of discovery which in time can form the emotional foundation for a satisfying career in biology.

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APPENDIX A

EXTRACTING & SEPARATING THE CELLULAR PIGMENTS OF RED ALGAE

The algae are endowed with the greatest variety of pigments within the plant kingdom.

I. Two groups of pigments may be isolated for study with reasonable care and patience.

   1. Chlorophyll A - medium green
   2. Chlorophyll B - light green
   3. Carotinoids - yellow

   The second group is water soluble:

   4. Phycobilins
      a. Phycoerythrin, highly polar - purple
      b. Phycoerythrin, less polar - red
      c. Phycocyanin - blue

II. Procedure for extracting the pigments:

   A. Make the water extraction using hot water in a mortar and pestle with a little sand. This will fracture many cells and the hot water will kill the cells, making the membrane more permeable. After a rich water extract has been prepared, it should be filtered and the fluid portion concentrated by evaporation.

   B. Prepare the methanol extract using 95% methanol, a mortor and pestle and sand.

III. Procedure for separating the methanol soluble pigments:

   A. Prepare a starch column.

      Hints: a. Starch tends to pick up materials from the air so that it becomes a poor absorber. Always use absolutely fresh starch!

b. Pour starch into tube without tamping or ramming--tap with ruler or pencil as you pour very slowly--column will not work if there are air pockets!

c. Pouring starch into column of petroleum ether, letting it settle, and drying away the petroleum ether sounds like a wonderful way to prepare columns, but has proved to be unsatisfactory!

B. If phycobilins alone are being separated the column should be of Brucite (calcium hypophosphate, $CaHPO_4$). In this case, elution is with water which contains .01-.001 Molar Na_2HPO_4 to make it alkaline.

IV. Adsorptive separation of the methanol soluble pigments.

A. Pour some of the concentrated methanol solution into the reservoir at the top of the starch column. As the solution moves down the column watch for air spaces not previously noticed. If such are found, a new column must be prepared.

B. When the pigments have dispersed themselves through the column (yellow carotinoids will go on through, most likely, and will be caught in the vile inside the vacuum jar) pipette the solution from the reservoir and replace with petroleum ether. This will improve the purity of the bands of pigment. Pull this through the column and allow the column to dry to the consistency of paste.

C. Push the starch paste from the column using a wooden plunger just smaller than the bore of the column. Go "mining" along the veins of the pigment "ore" if complete separation is desired. Resorb the fractions with alcohol, decant and recover by evaporation.

V. Adsorptive separation of the water soluble pigments:

A. Repeat the procedure used with methanol solution, except that the column should be of Brucite and elution should be as per III-B rather than petroleum ether.

B. Once a good, clear Bruicte column is obtained, it can be kept for many months in a refrigerator if wrapped to prevent light from reducing the colors.

FIELD ORIENTED, BI-LEVEL APPROACH
TO A GENERAL EDUCATION MARINE BIOLOGY COURSE

FIELD ORIENTED, BI-LEVEL APPROACH TO A GENERAL EDUCATION MARINE BIOLOGY COURSE

by

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Simply stated, the question is: What do you as the Instructor do when you are confronted with a general education class half of whom have a college level biological background and half have no background whatsoever in biology? Your answer might be: Never let it get that way in the first place!

Even though this is a correct answer, let me briefly recount the circumstances which led Cerritos College to offer this course at all and maybe you will recognize a familiar problem.

Five years ago, when this course was first proposed, there were very few precedents which could be used to "sell" marine biology as an appropriate J. C. offering. Our curriculum committee regarded this, quite correctly, as something of an innovation. They anticipated a low enrollment initially, especially if the course had prerequisites and was aimed at biology majors. Finally, if the student interest was as great as our presentation would seem to indicate, then the course should be open to anyone.

Since the four year colleges to which most of our students transfer would only allow "free elective," non-major credit, it was decided to open the course to any bodies warm enough to register. Thus, we began Marine Biology for 3 units credit, two hours of lecture and 3 hours of lab, offered in the Spring only, and limited to 20 students.

The limitation on class size was based solely on the need for a small group if we were to effectively engage in the extensive field work which characterizes the course.

As predicted, the enrollment was low initially, but the class has closed the first few days of registration during the last two years.

How, then, to deal with the great disparity in backgrounds among the students in the class? Two methods used in conjunction have proven moderately satisfactory: one, assigning an investigatory term paper to the students with a background in biology and a collection of 75 properly identified specimens[1] with data, etc. to the less prepared group, and two, going out in the field as much as possible. I will comment about the latter aspect only.

We schedule the lecture-lab time as a single 5 hour block Friday afternoons. This permits us to go in the field regularly without interfering with other classes. The field trips taken are generally as follows:

1. Rocky intertidal-at high tide! There is simply too much to see in this environment to expose a class suddenly to it. We work with *Ligia*, *Pachygrapsus*, *Littorina*, *Balanus*, and little else except to exclaim over the occasional anemone or urchin. In this way they break in gently and are forced to look hard for new organisms.

   We generally also pull a beach seine the same day on a sandy beach to provide some materials for future labs. For this latter activity we use an 8' Lawrence dinghy (having been turned down on several requests for a boat, I'm sure no one in the business office knew what a "dinghy" was when the purchase was ok'd!) and a 100' stream seine borrowed from a local four year institution.

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[1] In view of the present depauperate condition of our intertidal areas, this requirement is being deleted in future classes.

2. Rocky intertidal--at low tide. Same place as above. Other than the normal intertidal observing, I have the students take tidepool temps over a three hour period and strip a 1/4 meter section of mussel bed. This material is brought back in plastic bags and frozen until the following week's lab when all organisms are counted and identified.

3. Navy boat trip: The Navy has been most cooperative in letting us utilize the services of one of its mine retrieval boats at no cost to our District. We collect plankton and tow a cage dredge for mud and sand biota. I probably shouldn't say anything about this free boat business; We were the first J.C. to go on the "Velero" (no charge)--a great experience--the best of all! Now we can't get on board because of the pressure of other funded programs.

   Likewise we had some great experiences with the Lockheed "Sea Quest" but we are now priced out of that one. Those trips were on a rental basis--and well worth the money.

   We have $400 in our rental budget and that simply does not go very far if you want a well instrumented vessel! Suggestion: If you can raise more rental money via NDEA or NSF, the expense is well worth it. We chartered the Orange County boat this year and that trip was successful.

   Another way to get out in deep water is to find a yacht with a cooperative owner willing to take you out both for variety and interest for him and as a tax write-off. Such vessels are around--this year we had a highly successful--and free--trip into the kelp beds on a 50' converted purse seiner.

4. Mud flats--or how to live in mud and like it! Shovels, screens, and enthusiastic student labor make these trips among the most instructive. Students are amazed to find out how organisms adapt to this environment.

   A biology major looks at relationships and the others are intrigued by the activity of a jackknife clam's foot! There is something here for everyone. Besides, returning to the campus covered with mud is a status symbol!

5. Pilings and floats--This is one area where nobody objects to collecting--if you ask around, first. There is tremendous variety of tunicates, sponges, worms, mussels, nudibranchs, and amphipods which can easily be collected. Identification back in the lab is not quite so easy, but the view of a live Styella with its tunic

> covered with symbionts is something students do not readily forget.

Does all this activity satisfy both groups of students? At least the skin diver will know what to look for which will make his recreation that much more enjoyable. The biology major adds to this the feeling for the marine environment as it really is--not as pictures and pickled plankton make it appear. There is, in my opinion, no substitute for field work. However, does this, by itself, answer the problem?

My feeling is that it does not primarily because the instructor, even in a field situation, is obliged to duplicate the rudiments of biology which are already a part of the major's knowledge stores. By the time you get to the new part, much of the attention of half the class has been lost. If you don't build it in this way, then the non-biologists are completely frustrated. The result is a compromise: the undesirable mediocrity that inevitably comes when you try to satisfy everyone.

Next semester, there will be a prerequisite of a college level general biology course for all the marine biology students.

USING THE AVAILABLE ENVIRONMENT

USING THE AVAILABLE ENVIRONMENT

by

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INTRODUCTION

The use of living organisms in the teaching of biology, and especially marine biology, enhances the laboratory phase of the unit whether it be at the elementary or at the advanced university class level. Since the living organism is alive and doing something, the class shows greater interest in knowing something about the organism than if the same organism was a preserved specimen. Perhaps the chief advantage of the use of preserved material over living material, is that the organism is available in your laboratory at the specific time your wish to use it. The use of living marine organisms in the laboratory creates special problems for the teacher, namely, (1) the time to collect the specimens, (2) where to collect the specimens, (3) what organisms to collect, and (4) how to keep the specimens alive until they are to be used in the classroom.

The rocky shore intertidal environment is said to be that area on Earth where the greatest diversity of life occurs. This environment is limited in the Los Angeles-Orange County area to the Palos Verdes Peninsula and to the Corona del Mar-Laguna Beach-Dana Point area. The conservation of marine life in these intertidal rocky areas becomes a difficult problem when one considers the millions of people living nearby, with more leisure time than ever before, and more interested in marine biology than ever before. A more immediate problem for the teacher of marine biology is that this environment is only accessible during a minus tide series which is approximately every two weeks and then only for a limited time during the day or night. The result is that either the teacher goes to a considerable amount of time, effort, and expense (usually non-reimbursed) to collect this material or he reverts to the use of preserved material. Since the date of the minus tides may be as much as two weeks from the intended time to use these organisms, the problem of maintaining these organisms increases with each day.

The purpose, therefore, of this account is to call to the attention of the teacher of marine biology the use of a specific environment which will minimize the amount of time spent in solving the four problems listed above.

THE USE OF A BAY

A bay is defined as a body of water which is recessed from the ocean but maintains a connection to the ocean. The salinity of the water in the bay is more or less the same as oceanic waters. An estuary is similar to a bay but differs only in that rivers flowing into it produce a salinity gradient. A harbor is similar to either a bay or estuary but differs primarily in that man has altered the area for shipping. In Southern California most of the protected waters have normal salinity, except immediately following the infrequent winter rains, and have been altered to a greater or lesser extent by man. The Los Angeles-Long Beach Harbors were originally a bay but now represent the most extensively developed harbor in Southern California. Alamitos Bay, in the city of Long Beach, and Newport Bay, in the city of

Newport Beach, are the two largest bays in the Los Angeles-Orange Counties area and they have been altered considerably by man for recreational purposes. Other similar and accessible protected waters in Southern California include Santa Barbara Harbor, the Ventura Marina, Ventura County Marina, Playa del Rey Marina, Kings Harbor, Huntington Harbor, Dana Point Marina Oceanside Marina, Mission Bay, and San Diego Bay. Generally unaccessible protected waters include the military bases at Port Hueneme, Point Mugu, and Anaheim Bay.

THE ENVIRONMENTS OF ALAMITOS BAY

Since the majority of my experience has been in Alamitos Bay (Figure 1), the following discussion will be confined to this body of water; however, the comments made here will apply to a greater or lesser extent to all the other protected waters of Southern California. The entrance of Alamitos Bay (Figure 1, A) consists of large rocks which support a rich intertidal fauna and flora similar in species composition to a rocky intertidal shore. The beach just within the bay (Figure 1, B) is composed of sand which is stable, and it supports various groups of animals which burrow into it. The beach in the vicinity of Figure 1, C is composed of about equal proportions of sand and mud. Very little sand is present in the vicinity of Figure 1, D and E. Mud flats are found in the upper reaches of the bay (Figure 1, F). Each of these intertidal beaches has a characteristic assemblage of animals which may be found on the surface, burrow into it, or construct tubes in it. Collection of material from the jetty and beaches requires a minus tide for best results.

Many boat docks are located throughout Alamitos Bay (Figure

1, G). Boat docks are buoyed up by floats. The docks and floats are kept in place by either concrete or wooden pilings. The shores of the marinas may be lined with rocks or made of concrete walls which are protected at the base with rock rickrack. Each of these niches has their own specific group of organisms. All but the floating docks require a low tide for collection of material. The boat floats rise and fall with the tides and are therefore, always at the surface of the water. Material can be collected from the floating boat docks at anytime; minus tides are not required. Additional environments in Alamitos Bay include the water mass and the subtidal bottom.

SOURCES OF TEACHING MATERIALS

Since a teacher's time is limited and since it is desirable to use living material in the teaching of biology, it is of particular importance to be able to collect material with the minimum of time and effort. A bay environment offers some unique opportunities not only in affording a diversity of marine life but also minimizing the amount of time spent collecting. Over 240 species of plants and animals are known from Alamitos Bay (Reish, 1968); these include representatives from these animal and plant phyla:

Protozoans	2	species (many more present but have not been identified)
Sponges	3	
Coelenterates	6	
Ctenophores	1	
Platyhelminthes	2	
Nemerteans	2	
Polychaetes	80	
Mollusks	45	
Crustaceans	33	
Ectoprocts	12	
Phoronide	1	
Chaetognaths	1	

Echinoderms	10 species	Chlorophytes	3 species
Tunicates	5	Phaeophytes	4
Fish	24	Rhodophytes	9

Each of the different environments described above can be a source of many different forms of life. The most convenient ecological niche to collect from in Alamitos Bay is the boat floats not only because of its widespread occurrence in the bay but also because they can be reached at any time. The floats are always just beneath the surface of the water and one only needs to reach into the water to collect many different species of organisms. One bucket full of bay mussels and its associated organisms will yield a great diversity of plant and animal life. The following groups of organisms have been taken from the boat floats in Alamitos Bay:

Sponges	3 species	Ectoprocts	7 species
Coelenterates	5	Phoronids	1
Platyhelminthes	2	Echinoderms	2
Nemerteans	1	Tunicates	5
Polychaetes	18	Chlorophytes	3
Mollusks	11	Phaeophytes	3
Crustaceans	14	Rhodophytes	5

Not all of these organisms will be present at any one time within the bay mussel community of the boat floats. Greater diversity in terms of species and specimens occurs during the summer months and fewer species are encountered during the winter months especially immediately following rains.

The intertidal beaches offer a diversity of animal life but minus tides are necessary for maximum benefit. Some forms may occur on the surface, but the majority of the animals either burrow into the sand or mud or construct tubes within it. Collection of these animals is greatly facilitated by washing the material through a screen and utilizing the animals retained on the screen. The species of animals inhabiting this environment varies according to the amount of sand and mud present. This environment is particularly rich in polychaetes, mollusks, and crustaceans.

The rock jetty at the entrance of Alamitos Bay contains many of the same species of plants and animals as can be found along the rocky intertidal shores of Southern California. It is especially rich in different species of polychaetes, gastropods, crustaceans, echinoderms, and algae.

Pilings are another source of material which can be collected during low tides. The species present depend upon the location of the piling within the bay.

The bay environment can be of convenience in collecting plankton and bottom samples. Boat docks extend out from the shore and the water is generally a minimum of 10 to 15 feet deep at low tide. Plankton hauls can be made with ease at the ends of these docks. The species of plankton encountered in a haul will vary considerably depending upon many factors such as location, time of the year, and the current and tide pattern. Organisms such as copepods, chaetognaths, ctenophores, jellyfish, and all types of larvae can be collected in this way. Samples of the bottom can be made with small bottom grabs to collect the subtidal sediments and the animals living in this material. Neither of these collecting methods require the use of a boat. Another method of collecting subtidal animals is to suspend a gallon jar in the water for a period of one to three months. A rope is fastened to the jar and the dock. Larval stages of bottom animals settle within the gallon jar and begin to grow. Other organisms, for example Obelia, attach to the rope and can be collected with ease when needed.

Many fish inhabit bays either permanently or temporarily, but because of local and state laws and regulations, it would be wise to check with the California Department of Fish and Game before collections are made for fish.

USE OF THE BAY FOR FIELD TRIPS

Because of the great diversity of environments within the bay, as described above, it is possible to visit many, if not all, of these areas within the course of one minus tide. In one field trip the student can get some idea of the importance of the environment in determining species distribution. Pilings are particularily useful for demonstrating intertidal zonation.

USE OF LOS ANGELES--LONG BEACH HARBORS TO DEMONSTRATE THE EFFECTS OF INDUSTRIAL POLLUTION

The people of the United States and the World are more conscious of the effects of all types of environmental pollution than ever before. People who live in large cities have witnessed the effects of air pollution, but very few have ever witnessed for themselves the effects of water pollution. They may have seen pictures or read about water pollution, but that is the extent of their experience. The inner harbor area of Los Angeles-Long Beach Harbors are highly polluted largely the result of industrial pollution. Oil refinery wastes enter Los Angeles Harbor via Dominguez Channel (Figure 2). These wastes deplete the dissolved oxygen from the water and exclude any microscopic life from living in the area. Many small boat docks are located in the region indicated as A through E in Figure 2. Some measure of the effects of pollution can be readily observed by observing the organisms (or lack of organisms) on the boat floats. No organisms are found on the boat floats in the vicinity of A, Figure 2. A few organisms may be seen during some months of the year in the vicinity of B and C, Figure 2. Generally about five species of organisms may be observed in the vicinity of D, Figure 2. The boat floats in the region of E in Figure 2, contain from 10 to 20 different species of plants and animals. Thus, one can see, within an hour or two, one of the effects of pollution--the reduction in the number of species present.

SUMMARY

The use of bays and harbors in the teaching of marine biology offer the teacher a convenience in collection of material for classroom use as well as for class field trips. Some of the uses have been discussed herein. The bay can be used in many additional ways depending upon what is desired and the level of the class.

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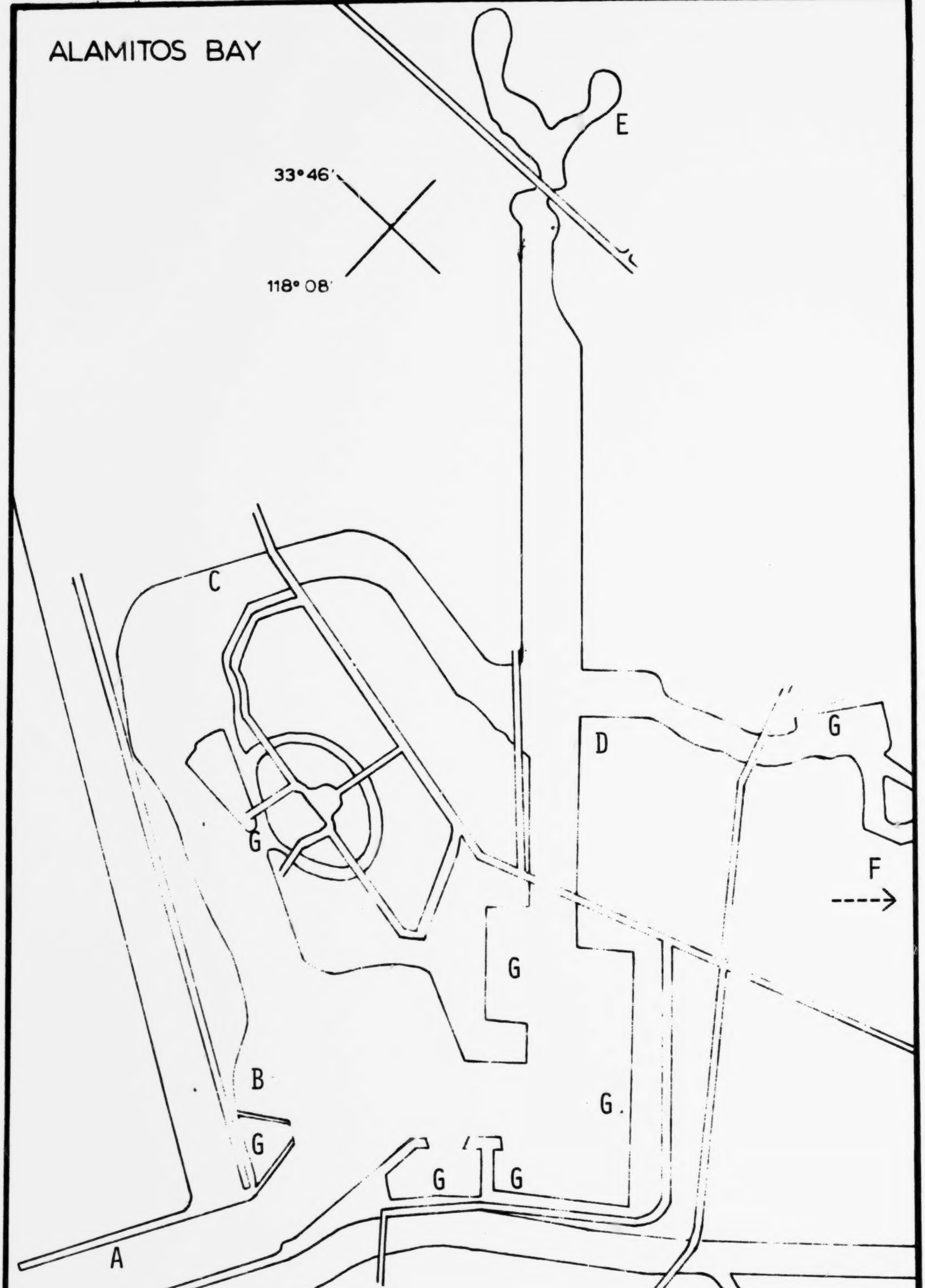
ALAMITOS BAY
33°46'
118° 08'
E
C
D
G
G
F
G
B
G
G
G
G
A

FIGURE 1

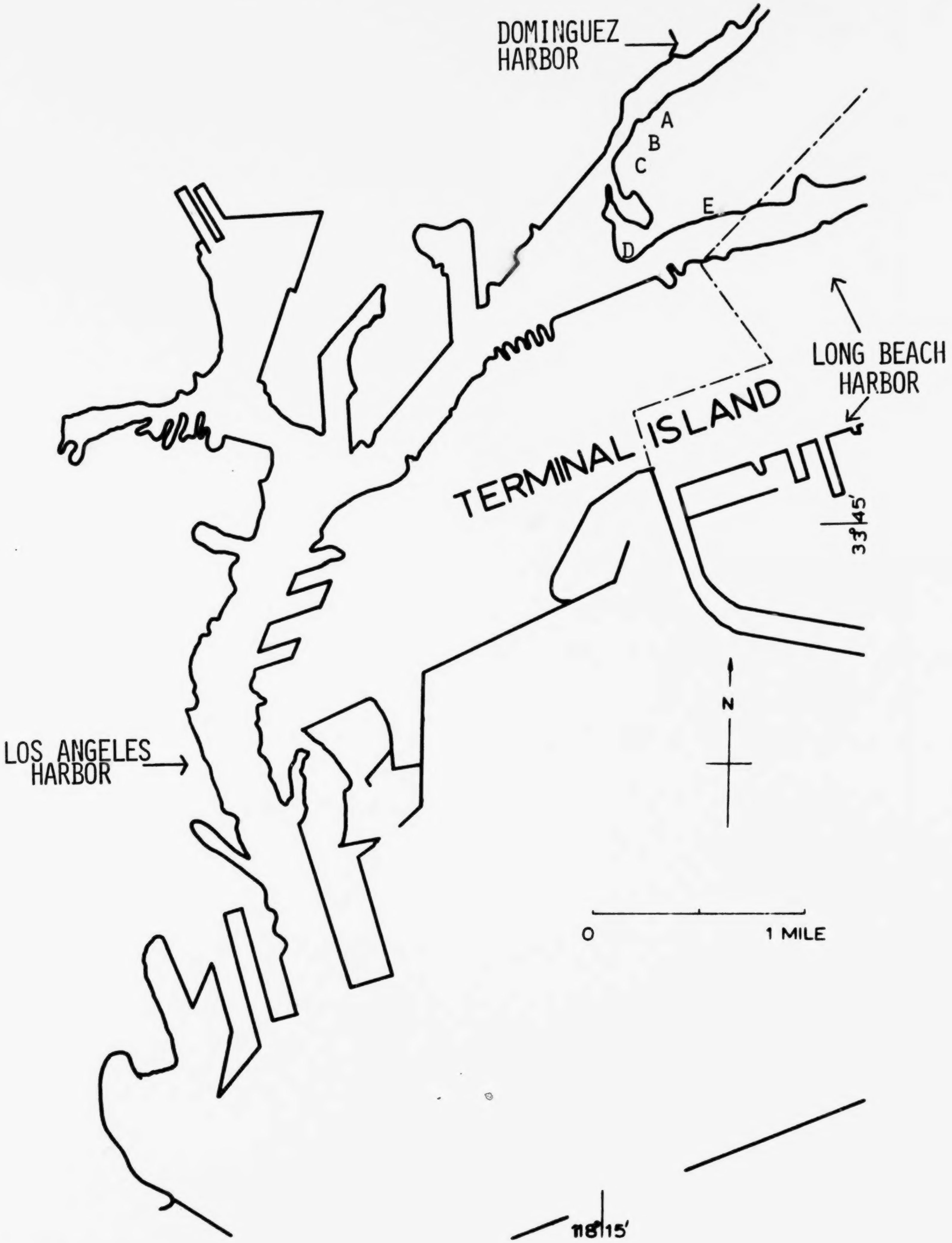
DOMINGUEZ HARBOR
A
B
C
D
E
LONG BEACH HARBOR
TERMINAL ISLAND
33°45'
N
0
1 MILE
LOS ANGELES HARBOR
118°15'

FIGURE 2

ILLUSTRATING THE MARINE LECTURE

ILLUSTRATING THE MARINE LECTURE

by

Dr. Gilbert W. Bane
Department of Population
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University of California, Irvine

As an instructor of the marine sciences you have an unexcelled opportunity to capture the attention of your audience and to present a wealth of ideas with a minimum of effort. Interest in the oceans is steadily increasing and with it a growing need for trained teachers. It is not enough for us as instructors to read and present factual information. To be modern we must take advantage of every illustrative resource at hand, even to the extent of transporting classes to the seashore, bringing the sea into the classroom in the form of aquaria, and all other media that we can devise. For those of you who are adjacent to the ocean it is rather easy to hold a successful lecture if you but spend the time to gather examples and illustrations from the sea. For the remainder of this discussion I would like to present some techniques of illustrating the marine science lecture.

The primary purpose of illustrating the lecture is not to entertain your audience, but to impress learning experiences so vividly on the mind of each student that he will never forget the lesson. At the high school and collegiate levels, highlights of your lecture material (and we must assume that it is not textual) should be reproduced and distributed at the beginning of the lecture. Then the student need not worry about writing down each thought, but he can concentrate on the intellectual stimulation provided. Space should be left on the handout sheet to allow for additional notes or sketches. A ditto machine is indispensible for the optimal preparation of a lecture.

Handout sheets are perhaps even more important during lectures on field trips; but, your lecture should be delayed until towards the end of the field work, so that students have had a chance to expend some of their eagerness and are better able to relax and absorb information. We must assume that the class has been introduced previously to the subject of the day's activity. Illustrative materials for this lecture are close at hand and now should be foremost in the student's mind. Anything said at this time should help to reinforce the field experience.

A particularly vivid experience of this nature occurred in a marine ecology class of mine last year when the students went to sea on two small vessels to capture and study sharks. While the lines were being fished, I lectured on the subject of primitive chordates. Some of the members of this group are the pelagic salps and the sessile tunicates, creatures which classes rarely study and seldom get an opportunity to see alive. As I lectured, four different species of salps drifted near the boat and were captured for observation. Additionally, I selected several Newport Bay forms of tunicates which were growing on the undersides of the boats. Thus, I could make good use of the living material which was available. This was significantly more meaningful than bringing preserved material into the classroom. We should avail ourselves of every possible aid to student learning that may become available in the lab or on the field.

A very popular marine ecology field trip is to tide pools at low tide. If properly arranged, such an experience can illustrate many aspects of oceanology, including: Chemistry, physics, geology, ecology, taxonomy, and conservation. Again, your lecture will be most effective at the conclusion of the trip. Due to the many educators taking multitudes of students to the beach, many of the less common organisms are disappearing from our coast. As they reappear, they are quickly snatched up by students and crammed into buckets with hundreds of other organisms. Before the end of the day, most of the creatures are dead and will be discarded. What have these students learned? Basically, how to kill marine animals through anoxia! Better use of the intertidal situation can be made when students are urged to search all the local habitats for organisms and then to construct an artificial tidepool around which the lecture is based. Each animal in turn is discussed from both a systematic and an ecological point of view. After the lecture, the students should return the organisms to their natural habitats as a dynamic lesson in conservation. Eventually, the citizens of our beach communities will meet the need for a marine facility and will build suitable aquaria for classes and the public, thus helping to preserve the natural intertidal setting and offering better opportunities for studying marine life. The sooner that they can be convinced of this, the sooner students will benefit and animal life saved.

CLASSROOM

It is not always easy to know whether the best method of illustrating classroom lectures is to show material at the time of the lecture or to lecture first and then present the illustrative material. In the latter method, the student gets a second chance to hear the material and can concentrate without having to divide his attention among his notebook, the demonstration, and the lecturer. At times, as in the case of film strips or movies, the lecture must accompany the presentation for the best results.

FILMS

Films on the various disciplines of oceanology are available from many organizations including the United States Navy Hydrographic Office, the United States Fish and Wildlife Service, California Department of Fish and Game and fisheries departments in other states. Private industries, such as Standard Oil, Douglas Aircraft, and U. S. Divers, and universities such as the University of California Extension and the University of Washington are additional sources for such films. Many films are free to classes or may be rented at a modest charge. In schools distant from the sea, films are indispensable for the classroom. An extensive list prepared by Dr. Andrew Rechnitzer follows this discussion.

TELEVISION

Videotapes of experiments and of field trips are a most useful way to record significant observations and ideas. They may then be replayed in the classroom along with the lecture. Closed circuit T.V. can be extremely valuable when used in conjunction with experiments on small items or organisms. With the camera focused on the subject, even the student in the back of the room can see clearly what is happening as he watches a T.V. monitor.

SLIDES

Thirty-five millimeter color slides are perhaps the most commonly used and the best illustrative source. Many slides of marine organisms can be purchased from oceanographic institutions, aquaria, and suppliers of scientific products. One caution, however, if too many slides are shown, their effectiveness is reduced, for students tend to sit back, relax, and enjoy the program without the concentrated attention essential for maximum learning. To recover the attention of those who might have drowsed, a dramatic slide should be inserted occasionally. May I urge you to omit slides depicting complicated structures or slides which cannot be properly read. Tables and graphs with too much data and too fine print should be avoided. If you will take a few minutes before class and ditto any detailed material, each student would then be assured of receiving the exact information and he would not have to guess at his drawing in the dark.

OPAQUE PROJECTOR

It is sometimes necessary to show pictures of graphs which are not worthy of mass reproduction. An opaque projector is excellent for projecting the material onto a screen.

OVERHEAD PROJECTOR

An excellent technique for presenting graphic material during the lecture is the use of an overhead projector. With this piece of equipment, the material is drawn by the lecturer on a plastic sheet that is projected onto a screen. This is superior to blackboard drawings because the plastic sheets may be prepared with a basic outline prior to the lecture; another advantage is that the lecturer can speak _to_ the class instead of talking to the blackboard with his back to the students.

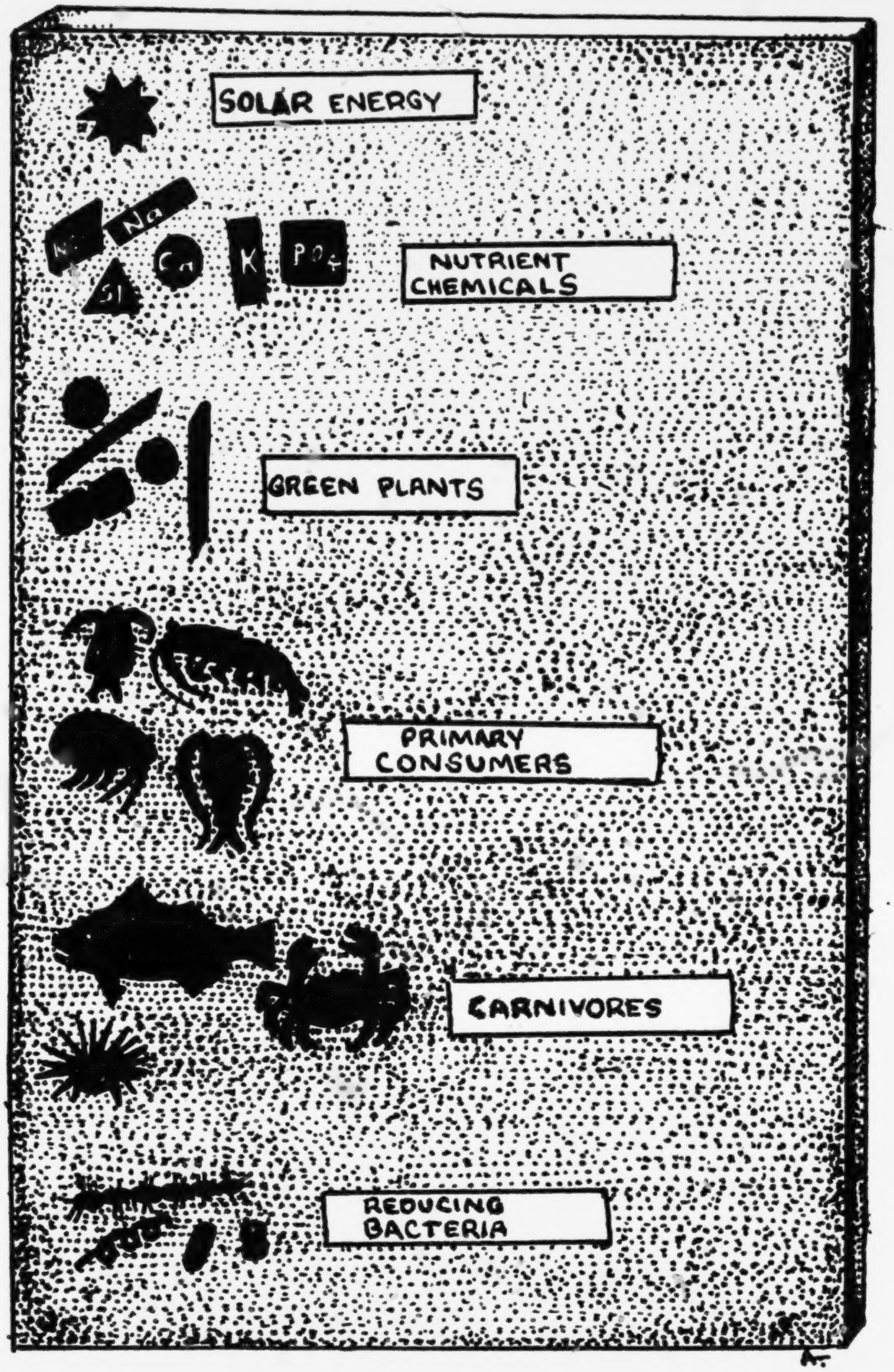
FLANNEL OR FELT BOARD

A flannel board, or a felt board, is a common piece of equipment in the primary grades; it retains its usefulness and may be more effective in some university lectures. For instance, in depicting biological cycles in tide pools, figures may be precut for the lecture: the sun as the basic source of energy; multicolored chemicals as the basic building blocks; green algae as the primary photosynthetic producers; grazing forms as the primary consumers; larger fish, starfish, and crabs as predominant carnivores; and bacteria as ultimate reducers. The same flannel board may be used to demonstrate life cycles of plants or animals or ecological phenomena such as the food web or the Eltonian pyramid. In the latter case, the pyramid may be synthesized on the flannel board to depict a continuing loss of energy at succeeding trophic levels. Students may later experiment with the cycles on the flannel by introducing additional organisms or by eliminating various components.

One further thought in presenting your lecture dramatically and interestingly is the introduction of living or freshly-captured material into the classroom. You can collect a living organism before class and build your lesson-plan arount it. There are an infinite number of sources of this type of material, including fish markets, commercial fishermen, and biological supply houses. Most fishermen, either sport or commercial, would be willing to provide fresh material if they were approached.

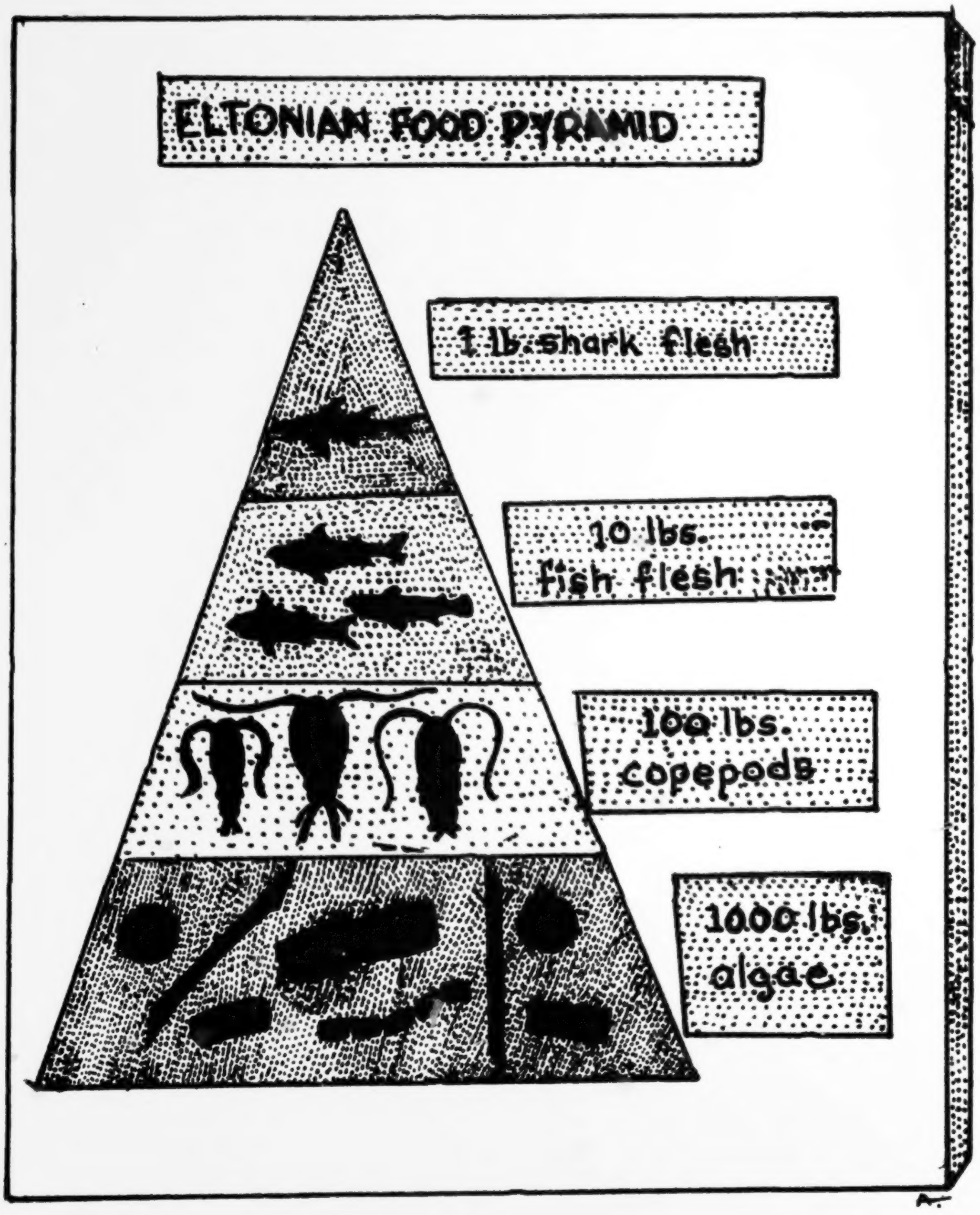
To be an effective teacher, you must be resourceful. The examples given here are but a few which can be adapted to any level of students. The wealth of material and ideas in oceanography is available to use; it is up to you to make the best of these resources and present it to the students.

FIGURE 1


SOLAR ENERGY
Na
No
Ca
K
PO4
Si
NUTRIENT CHEMICALS
GREEN PLANTS
PRIMARY CONSUMERS
CARNIVORES
REDUCING BACTERIA

Flannel board used to illustrate biogeochemical cycles in a closed community such as a tide pool. The flannel figures are pre-cut and are easily stuck to the flannel background during the lecture. For a more dramatic presentation, bright colors are used for the flannel figures.

FIGURE 2


ELTONIAN FOOD PYRAMID
1 lb. shark flesh
10 lbs. fish flesh
100 lbs. copepods
1000 lbs. algae

Flannel board used in a lecture on trophic levels to represent the Eltonian Pyramid and subsequent energy losses at each successive level.

OCEANOLOGY IN TODAY'S HIGH SCHOOL

OCEANOLOGY IN TODAY'S HIGH SCHOOL

by

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Education is often accused, sometimes justifiably, of lagging out of phase with technology, of developing a program of instruction only after the need has become severely critical, as in the case of nuclear physics and aerospace. With oceanology, however, we have the opportunity to lead.

Now in its infancy, this study of inner space can be nurtured and developed by the academic community; and by the time it has reached adolescence, we can be prepared to supply the scientists and knowledge needed to bring it to full maturity.

There is no more logical a point of beginning than our secondary schools. The high school student, resilient, open-minded, and eager, is capable of launching himself into a career in this new medium. Too often we have anesthetized his enthusiasm and allowed it to wane. We have introduced new teaching innovations, new methods of inquiry, and new concepts of learning only to negate it all with a curriculum which did not allow for points of new investigation. Study and research into the ocean cannot be limited to the university. The high school is as capable of original research as the university, and, if properly guided, as competent.

In September of 1967, the Capistrano Unified School District Board of Trustees, urged by its administrators, instigated a program of marine science at San Clemente High School. Termed Marine Ecology, instruction is offered the advanced science students. The year-long curriculum has three major divisions: Physical Oceanography, Marine Biology, and Independent Research.

The philosophy which underlies our complete offering is that our course is student-oriented, where theory is applied to the practical and where the student must come to his independent conclusion.

PHYSICAL OCEANOGRAPHY

Our course of instruction first includes the disciplines of geology subdivided into bathymetry, origin of structure, stability, and relative motion. The students learn to read geodetic and bathymetric charts and then are given an area to plot. Working in teams, the students take bottom samples. They use sounding lines to compute depth and then combine their information into one marine geological chart.

The study in ocean chemistry and physics begins with the characteristics of sea water: its density, salinity, stratification, clarity, and temperature variation. From this, students are taught to titrate for chlorinity and dissolved oxygen, measure depth and pressure with bathythermograph, and graph and plot surface and subsurface currents. The use of marine instrumentation is studied in detail and culminated in its usage aboard the Orange County Schools Marine Science Floating Laboratory.

Wave and current morphology and motion are examined in the laboratory through the use of wave tanks where refraction, reflection, and basic wave theory are taught. Then the open spaces of the San Clemente Pier and the ocean become our laboratory and the students compute wave length, period, and velocity.

Tidal currents and bores are examined, graphed, and predicted, with the students learning to differentiate between semi-diurnal, diurnal, and mixed tides as well as predicting perigean and apogean occurrences.

MARINE BIOLOGY

Marine Biology is basically a study in seashore ecology using the basic divisions of supra-littoral, littoral, and sub-littoral and applying them to the geographical categories described in Ricketts and Calvin Between Pacific Tides. Research teams first identify all plants and animals in their respective zones. Then grouping them taxonomically, they study the characteristics of the group. If the anatomy and physiology of a particular species is not clear, then that one is returned to the laboratory for further study. Particular care is taken to insure a representative benthic sample of each zone for microscopic study along with samples of plankton to be examined later in the laboratory.

Just prior to the building of the new Dana Point breakwater, the classes as a whole observed the ecosystem that existed, gathering population data, computing ratios between the species and delving into the factors which controlled and modified them. It will be interesting each year as the harbor goes from construction to operation to observe the evolution of life that follows.

Our study of the marine vertebrates follows the traditional approach in which animals are studied according to the phylogenetic scale. The main point of departure is that each group is compared to the next, and again the student must come to a conclusion concerning why a particular species is successful in that environment.

INDEPENDENT RESEARCH

Students are asked to undertake a year's study of one particular facet of oceanology that most interests them. They are given *carte blanc* use of the laboratory facilities and the library and the time to confer with those faculty members who can best aid them. They are encouraged to develop research teams to take best advantage of individual strengths. Periodically they give an oral presentation on their research progress to their colleagues where their efforts are questioned and criticized.

This year the marine science students at San Clemente have researched the following areas:

Ocean Currents. Using a series of nine hundred drift cards, one research team has plotted the offshore currents between Dana Point and Cypress Shores. Using a fourteen foot outboard boat, the students ran a geometric grid releasing fifty coded floats at eighteen different intervals. Each plastic float contained an information card which had pre-postage and was mailed by the finder back to the school. From these cards the students computed the direction of drift and the effect of geophysical projections on the drift. Dr. Joseph Reid of Scripps Institution conferred with the students on their original research and commended them on their progress. Several agencies, including life guard services, Coast Guard, and Army engineers, are requesting information on their findings.

Plankton Ecology. This high school research team is completing a study on plankton population in correlation with water temperature and salinity. Using a plankton net, the students take weekly plankton samples from the San Clemente Pier. They then compute the volume of water sampled through the net by multiplying speed of drift by the net volume by the duration of sample. In the laboratory they identify the species, compute the inhabitant density per cubic foot of water, and graph this information with the date, salinity, and temperature.

Taxonomy of Indigenous Crustaceans. Two students interested in crustaceans became involved in a complex study of the morphology of the animals. Their deep interest has now led them into studies of behavioral psychology, and they are currently constructing Pavlovian response studies using the Pachygrapsus crassipes (striped shore crab).

Taxonomy of Algae by Use of the Spectrophotometer. Interested in the physical properties of light and optics, one student is applying his knowledge of physics to the pigmentation of algae. By removing the pigmentation from known algae and plotting the the various wave lengths produced when the pigment is passed through the photometer, the student can recognize an algae by its characteristic light emission. The ultimate sought after goal of this young scientist is the taxonomy of an unknown algae specie by relating it to known species by its light emission characteristics.

These are but a few of the research projects that are currently under study by our students. They extend from the physical sciences to the biological to the behavioral. The methods of science inquiry used are not unique; they are the same scientific methods that have been used by people of imagination for centuries.

Presently our district is involved in a cooperative teaching effort where these independent researchers are utilized in the instruction of elementary school children. Each week students from kindergarten through sixth grade meet in our high school laboratory, on the beach, and at the tide pools where they are given instruction in basic science, marine ecology, and conservation. Thus these high school scientists return their knowledge to other younger, prospective scientists.

FUTURE PLANS

The reception of our program by the community has been magnanimous. It has sparked an interest in oceanology that has been unprecedented. The community at large is donating equipment, time, and money to the advancement of its study. In cooperative effort between the community and the schools, a marine science symposium is being conducted on our high school campus. This symposium will bring together leading scientists from education and industry to present their programs to our students, teachers, and laymen.

Next year our marine science program will take on two more interesting facets. Our school has been accepted by the U. S. Navy as a high school NROTC station. This will bring to our school permanent naval officers to teach navigation, meteorology, and naval engineering. Our technology division will in the fall offer courses in hydraulics and marine engines to those students who are interested in yet another approach to the sea.

With a natural marine environment at our doorstep and a school board and administration which are anxious to move forward, we envision further advances. In our plans we will develop a marine laboratory located on the shore where students and faculty can carry on research, and a district teaching museum, where elementary classes may go to receive instruction.

We have found that industry is ready and willing to help us in our endeavors, allowing students to visit their facilities and sending specialists to aid in our instruction. Scripps personnel have received our students and aided them in their research projects, and the Navy has loaned us films, and apparatus, and accepted us at their stations.

As always, the proof is in the product. Is our program a success? This coming fall fourteen of our students will enter Revelle College at the University of California at San Diego embarked, at least for now, on an oceanographic career.

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OCEAN SCIENCE AND THE TECHNOLOGIST

OCEAN SCIENCE AND THE TECHNOLOGIST

by

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The growing interest of the academic community in the ocean-oriented sciences has become particularly apparent in the last five years. Education of the professional ocean scientist has been an element of the curriculum of many universities for quite sometime. More recently, the education of the support personnel for the research projects at the university level has become a topic of interest and concern to educators. The meeting we have enjoyed today is an example of that general interest in the ocean sciences in the broad sense, and the educational needs and methods related to the oceans in the narrower sense. Such regional meetings are becoming more widespread and more sophisticated as the nature and the scope of the marine environment commitments become clearer. It is becoming practice for representatives of such meetings to transmit ideas to and obtain advice from state and federal conferences on educational matters. Curriculum development, technique development and evaluation of procedures, community service and other educational objectives benefit in scope and quality from these gatherings.

There is little doubt in my mind that the term "Ocean Science" in the title of this talk will be vague in the mind of any of my listeners. Quite the contrary, I suspect that each of us has a very specific meaning in mind for the term. I would also venture that there are nearly as many interpretations of the term as there are members of the audience! If you are the beneficiary of an education rich in biological science, then you will see ocean science as a biologically-oriented activity. If you have a strong math and physical science background, then your view of ocean science might be more concerned with waves, tides, currents and other aspects of physical oceanography. The ocean sciences also involve engineering, chemistry, geography and many more specialty areas. If, then, there is uncertainty regarding the seemingly obvious, imagine the confusion that results from the term "technologist!" The confusion is understandable, I believe, since most of us are not vocational-technical in our teaching orientation. This is, I regret to say, more common at the junior college level than it should be, considering that the vocational education charge has been placed squarely with the junior colleges. It is all the more unfortunate when one considers the impressive array of talents available on the junior college campus, talents that provide an excellent and broad base for technical-vocational education. We should use these many abilities for our vocational students as well as for those pre-professional students, biologists, chemists, physicists, microbiologists, engineers and all of the others. In my opinion, the same teacher can teach a mathematics course for the major and another for the student who will be an adjunct professional to a research team that is ocean science involved. It is a matter of "pitch" that is given the subject matter. The technologist is the well-motivated student who is broadly trained in the myriad aspects of the marine environment, able to manage a variety of logistic chores, observant and literate, factually honest and willing to continue to learn his trade. The description implies an enormous store of ready information by virtue of the "marine environment" phrase. Yet, upon examination, the marine environment and the sciences investigating or exploiting it are quite familiar.

Theoretical and applied research projects involving the research and development of the marine market can be divided into the physical and biological subject areas. The projects reported in the literature require diverse professional talents. Of the sciences concerned, the life sciences of Zoology, Botany, Biology and Microbiology are deeply involved. Man will turn to the sea for his food to a greater degree in the coming years as arable land is used for living space to accommodate our increasing numbers. Marine biology and biological oceanography will assume even greater direct significance in the pursuit of human welfare. Indirect importance of biological research goes beyond a search for food supplies. Fouling, pollution control, instrumentation sensitivities, medicinals such as bacteriostatic or bacteriocidal agents and other medical or paramedical investigations - to name a few possibilities - will occupy increasing numbers of professional biologists each year. The technology student, when provided a series of basic, biologically sound marine oriented courses, should be able to manage assigned tasks with a minimum of direction and supervision so that the professional biologists may attend to weightier matters.

The physical sciences have been involved in marine activities for many years. The geologists, physicists, chemists, mathematicians and meteorologists in the past were occupied with locations, analyses of minerals and water bodies and their masses and motions. Today, the geologists, for example, no longer content themselves with shallow water samples of random dredgings. Seismic techniques, gravimetric and magnetic anomaly equipment, rocket corers accurately directed to predetermined locations by underwater electronic location gear and numerous other technologically advanced materials make their results more precise and accurate. The chemists and physicists also have at their disposal a variety of modern implements for the analysis of the oceans. The vast wealth of data obtained by the new and sophisticated gear would overwhelm any standard form of data handling procedures. The ocean technologist must be prepared to manage the procedures of the data processing equipment presently available and have an adequate understanding of the methods employed in order to make the smoothest possible transition from one system to another as the sophistication of the equipment continues. Shipboard computers and data processing hardware are now becoming quite commonplace and the technologist must be able to make the most of the facilities. The litany could go on indefinitely - the meteorologist and the engineer, the cartographer and the information specialist - these and more of the familiar terrestrial occupations are being directed toward the sea and the exploitation of its vast resources. In the process of turning our eyes toward the oceans, we must evaluate the new experience in terms of older experiences. What the engineer of the class of '51 learned about marine engineering would be a small part of the requirements he finds facing him in actual practice today. The material simply was not in his text-book in his college years! His education prepared him sufficiently well, however, that he can find most of the solution to a marine problem from the store of information he has retained from college or which he has garnered from experience in the intervening years. This is the objective we, at Fullerton Junior College, have in mind when we direct students in the Oceanographic Technician curriculum.

Since the professional oceanologist cannot do all of the jobs necessary to complete a large project satisfactorily, he must rely on aides aware of the objective and methodology appropriate to it. These aides are, in my opinion, technologists. The technologists will be versed in the fundamentals of mathematics, physics, chemistry, biology and English. They will have taken elective courses in areas in which they have a particular interest or enthusiasm: mathematics, data processing, invertebrate zoology, photography and many other choices available in the college curriculum. From such a training regimen we will, I believe, obtain entry-level graduates who are capable aides in a variety of work billets. Fullerton Junior College students will have a summer work-experience requirement to fulfill. This may be onboard a ship, in a laboratory or in a commercial enterprise consistent with the student's particular interest. It is not our policy to turn out students with the same background to the point of identity. The basic curriculum is two-part: the general education requirements established by the State of California and the curriculum established with the aid of our Advisory Board that seems to suit our local needs best. If it appears that the student is interested in the chemical technologies, summer experience will be sought for him that will develop greater capability in that interest area. In preparation for shipboard work, we envision some ship time on vessels actually engaged in marine research or commerical exploitation. It is our belief that a student need not train on board ship for all on board tasks. A tower and cable and a winch will do nicely to learn the mysteries of the Nansen bottle or how to rig a plankton net!

The curriculum relies heavily on existing courses in the Fullerton Junior College catalog. The general education courses are known and their alternative courses are standard catalog offerings. Those courses required of the Oceanographic Technology student are:

Biology 1 or Biology 5AB or Zoology 1AB
Math A or Math 81 AB
English 51 or English 1A
Chemistry 3 or Chemistry 1AB
Geology 1 and 1L
Marine Biology 25
Physics 2AB, 3AB or Physics 10
Navigation and Drafting 33
Oceanographic Materials and Instruments 32AB
Introduction to Ocean Science 30

The electives recommended include: 1 Physical Geography, 3 Historical Geology, 1 Survey of Data Processing, 2 Introduction to Data Processing, 41 Computer Science, 3 Microbiology, 50 AB Electronic Construction Techniques, 51 Basic Electronics, 1AB Surveying, 29 and 30 Photography.

Of the courses listed, only Introduction to Ocean Science, Navigation and Drafting, and Oceanographic Materials and Instruments have been specifically designed for the Oceanographic Technologist. Our Advisory Board considered the content and caliber of the existing course offerings to be satisfactory for this new and dynamic program.

Navigation and Drafting 33 is a four unit course, three lecture hours and three laboratory hours, covering such activities as seamanship, deck management, small boat handling, navigational aids, bearings, charts, loran, radar, sonar, records, data handling and surveying methods, among other things. The student will have in excess of one hundred hours of contact in an integrated laboratory-lecture situation in this one semester course. The course, Introduction to Ocean Science 30, is a one semester course also. It will provide the student with an overview of the marine environment, its physical and biological parameters, marine resources and how they are investigated and utilized, various ocean oriented careers and similar matters intended to broaden whatever parochialism in outlook the beginning student might have. Math A or equivalent, Chem. 3 or equivalent and Geology 1 and 1L, singly or in combination are desired pre- or corequisite for this course. The two semester course in Oceanographic Materials and Instruments 32AB is very heavily oriented toward field station, shipboard or laboratory activities. Upon satisfactory completion of Intro. to Ocean Science 30, the technology student will enroll in this course designed to acquaint him with the materials commonly used in modern marine science and to relate his lecture subject material to the equipment with which he will ultimately be working in fact. We anticipate the cooperation of the marine instrumentation industries in the operation of this course. A number of electronics and engineering firms have indicated the availability of personnel and equipment for on-loan use. There is expectation of government funding for equipment purchase and rental. It is our intention to provide our equipment to Cal State, Fullerton and the Orange County Schools Marine Laboratory program on a loan-exchange basis as we develop an inventory. It does not seem prudent to duplicate the purchases of some of the very costly items that we will all need for the education of technologists or professional marine scientists. No formal agreement has been reached in this latter matter, but I foresee a regional cooperative arrangement, benefiting all of the Orange County schools involved in this educational effort.

Clearly, we are not attempting to provide specialists in marine technologies anymore than the senior institutions are presuming to develop marine specialist with a baccalaureate degree. We do believe that our program will provide reliable and well-informed young men and women to the ocean science complex in Southern California. We also believe that, broadly trained, a technologist will be better suited to further training as needed, once employed and assigned. It is toward these goals that our program was developed and for which we are working.

THE MARINE SCIENCE MAJOR

THE MARINE SCIENCE MAJOR

by

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The ocean is mankind's last frontier on this planet, and we can no longer treat the great waters as little more than a "home" for fisherman or highways for ships or bottomless areas for disposal of wastes. Although recent events have focused national attention on the oceans as a vast virgin realm with infinite promise, we have only just begun to prepare for embarking on a search into the sea in order to find solutions to ever growing problems, such as the need for food, water, minerals, power and weather control; and no less important is the matter of water pollution. Thus, if we are to efficiently utilize the sea, we must have a cadre of persons, trained at various levels of performance, who are aware of both the peril and the promise of the sea as a frontier which offers partial solution to the ever increasing needs of mankind.

How the problem of having enough trained persons to guide the use of the sea can be solved is a point of vast departure among many present day oceanologists. Yet, in spite of this disagreement, there has evolved a threefold need for the future: first, the encouragement of students to pursue the marine sciences; second, to have adequate educators able to guide students along lines to achieve their goals in marine science; and third, to produce a substantial number of persons with various levels of graduate preparations, i.e., oceanological technicians, research assistants, and individuals with a doctorate who can effectively participate in academic, industrial and government programs.

Southern California provides a geographically unique maritime situation that is unparalleled anywhere in the United States. Within a relatively small area are found some of the outstanding academic institutions providing marine science opportunities, _i_._e_., University of Southern California, University of California at Los Angeles and Irvine, California State Colleges at Fullerton and Long Beach, Fullerton Junior College, Orange Coast College and Golden West College. Within this radius also is the Orange County Schools Floating Marine Science Laboratory program serving to promote interest in marine science as a future goal. This illustrates an area providing marine science curriculum offerings from grades 7-12, junior college, college and university through graduate levels. Thus, Southern California institutions have programs which are adequate to meet the threefold need of the future.

One such program is that offered at California State College at Fullerton. At the present, persons interested in marine science may pursue the requirements for either a bachelor's or a master's degree in Biology.

A Bachelor of Arts degree in Biological Sciences requires one hundred twenty-four units including: 33-38 in biology; 14-18 in Chemistry; 8 in physics; 3-8 in mathematics; and a proficiency in a modern foreign language. In addition there are general education course requirements of psychology, social science, humanities, and fine arts and speech. All undergraduates in biology must complete a core curriculum of: Elements of Biology, Principles of Botany, Principles of Zoology, General Microbiology, Genetics, and Molecular Biology. Advanced undergraduate courses offered for those biology majors bent on marine sciences include: Biogeography, Evolution, Marine Biology, Marine Ecology, Algology, Invertebrate Zoology, Ichthyology, and Biosystematics.

Prerequisites for becoming a candidate for a master's degree in biology include a bachelor's degree in a pertinent undergraduate major and proficiency in a modern foreign language. Students must also have a GPA of at least a "B". Students may be admitted provisionally with limited subject or grade deficiencies but such deficiencies must be removed by completing additional courses with at least a "B" average. The graduate student must develop and complete either a specialized study plan culminating in a thesis, or a broad-based study plan culminating in written and oral examinations. All study plans must include graduate research and seminar experience. The requirements for the degree include 30 units of which 12 must be in graduate-level courses. In addition to the advanced undergraduate courses listed earlier, students interested in marine science may take several graduate seminars. These seminars include Tropical Marine Ecology, Vertebrate Zoology, Animal Behaviour, Advanced Ichthyology, Advanced Physiology, Molecular Genetics, Paleobotany and Temperature Regulation. The remaining graduate-level requirements are met by taking Graduate Research and/or Thesis.

The above program is labeled by some as being "Traditional," and indeed in many respects it is. However, it has a broad base which affords students the opportunity of preparing to become research assistants or it is equally suitable for those who plan to pursue a doctorate degree in a selected specialized area.

Beginning in 1969, several new courses will be offered in the marine science area at Cal State Fullerton. These courses, together with the present offering, will form the basis of a new master's degree program in Marine Science which will begin in 1970. This program will be structured so as to provide each student with a broad background in those aspects of marine science dealing with the basic concepts of chemistry, physics, geology and biology. Further, this program will center around the concept that as students progress towards a master's degree they should be able to provide on their own much more than is possible in the constrained environment of a series of successive core courses. This also includes the philosophy that regardless of the professional goal of the student his success is ultimately dependent on how well he can work and perform on his own. Within the framework of this philosophy the following new courses will be offered as part of this program: Biological Oceanography, Population Dynamics, Marine Science, Fishery Science, Marine Plankton, Productivity in the Ocean, and Oceanic Zoogeography. Also, a number of interdisciplinary courses are being prepared in the areas of Physical Oceanography, Marine Geology, Marine Sedimentation, Marine Engineering, Oceanological Methods and Instruments, and Polution Problems in the Sea. Further, a number of seminars will be offered dealing with specialized areas in the field of specialization of the staff, e.g., Crustacean Ecology, Trophic Structure of Coral Reefs, Marine Instrumentation, Polar Ecology, etc.

Students graduating from this new program should be equipped to teach oceanologically oriented courses at the high school and junior college level, or be able to carry out independent research projects, or be able to pursue and complete a doctorate program dealing with any of the various specializations which presently comprise the area of oceanology.

With the rapid advances in technology and the increased desire for using the potential of the sea, the Marine Science Major will become a strongly forged link in the success of the future. The degree of this success will be a direct reflection of the type of curriculum, the enthusiasm of the educators, and the degree of independent inquiry instilled in each student. We at Cal State Fullerton are trying to achieve these goals.

THE CATALINA ISLAND MARINE SCIENCE CENTER

THE CATALINA ISLAND MARINE SCIENCE CENTER

by

Robert Given
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The University of Southern California has established a Marine Science Center at Big Fisherman Cove. The Center is designed to meet specific academic, industrial and other requirements for long-range programs of research and development in oceanography and marine engineering. It consists not only of laboratories and programs for basic and applied research and for graduate education, but it also provides for related facilities to be established by private industry and by the Government.

The Marine Science Center is the response of the University to a clearly recognized need for expanded, inter-university research and educational programs related to the ocean, and to the development of the potential resources of the ocean in terms of both scientific knowledge and practical economic benefit. It is also intended to serve the rapidly increasing involvement by industry and industrial management in marine-related products and services, and by governmental agencies in oceanic research relating to national health, welfare and defense.

In order to meet these requirements, the Marine Science Center will provide in a single location the necessary academic and industrial personnel, advanced educational and research programs, and physical facilities and laboratories, which will permit an effective combinedeffort in attacking basic and applied problems in the exploration and utilization of the ocean and its resources. Such a unified Center, backed by the combined academic resources of our universities, by the management, scientific and engineering skills of select corporations and governmental agencies which will establish laboratories within the complex, and by the total industrial and scientific capability of the Southern California area, is believed to be without precedent.

PARTICIPATING EDUCATIONAL INSTITUTIONS

The first facility within the Center, the Santa Catalina Marine Biological Laboratory, has just been completed. It will be operated by the University of Southern California with the advice and counsel of a number of other major educational institutions in the Los Angeles area, University of California at Los Angeles, University of California at Irvine, University of California at Riverside, California Institute of Technology, the California State College System, Occidental College and Pomona College. The Marine Biological Laboratory will be devoted solely to research and graduate education, and its facilities will be freely available to the scientific staffs and graduate students of the participating institutions. An Inter-University Advisory Committee has been appointed to work with the University of Southern California in the establishment of policy for the operation of the facility. Each of the participating institutions has one or two faculty members on the Committee. The University expects that, based on this precedent, similar inter-university committees and facilities at Santa

Catalina will be established in Oceanography and Geophysics, Resources Development, Ocean Engineering, and other important areas.

SUITABILITY OF LOCATION

The physical site is uniquely suitable for the purpose of educational and research facilities in the marine sciences. Its proximity to the mainland, to the Southern California metropolitan area, to the participating and other educational institutions and their faculty and students, to industrial activities concerned with oceanography, and to military and other governmental research agencies, provide unmatched support. Specifically, the site provides:

> A permanently positioned oceanographic platform with immediate access directly from shore and from adequate harbors to an unusual variety of highly favorable biological, oceanographic, physiographic and other environments.
>
> Year-round operation in protected, semi-tropical waters of exceptional clarity.
>
> Adequate land, shoreline and water areas with control of their use and with protection from encroachment by other developments.

The first unit consists of a building, boathouse and diving locker, associated piers, ramps and floats, and other facilities for marine biological research designed to accommodate about 60 staff, students and service personnel. The initial capital investment was $1,950,000 of which $500,000 was granted by the National Science Foundation. The University of Southern California itself is contributing $500,000. The remaining $950,000 represents the contribution of the Santa Catalina Island Company and the Southern California Edison Company for access roads, utilities, sewers, and other essential supporting facilities. These figures do not include the unspecified value of nearly six acres of land which have been deeded to the University by the Island Company and Mr. P. K. Wrigley.

The first unit described constitutes about one-third of the total projected University research facility which will accommodate an expanded program not only in biology, but in other phases of marine sciences as well. It will be followed by other buildings needed for carrying on the manifold activities of education and research in all phases of oceanography. In addition to the University buildings, a master plan has been adopted by the Santa Catalina Island Company for the development of a community of 6,000 people, providing homes, schools, shops, and other necessities for those utilizing the Center and its related activities.

The Center also offers a new and unusual opportunity to industries engaged in marine science and engineering. Its physical location with immediate access to deep water and to a wide variety of highly favorable oceanographic, physiographic, biological and other environments is particularly valuable to research-oriented programs and to practical applications of the marine sciences in such areas as:

Oceanography
Meteorology
Biology
Geology
Geography
Instrumentation
Marine Resources
Acoustics
Communication Systems
Pollution and Water Supply
Data Processing
Anti-fouling Systems
Ocean Structures & Platforms
Deep Sea Installations
Environmental Effects
Transportation